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The Reaction Between Silica and Carbon

We heartily join Dr. Acheson's many friends and admirers in extending to him our congratulations on the award of the Perkin medal, and we congratulate with equal sincerity the Perkin Medal Committee on its choice. The apparently simple reaction between silica and carbon was the starting point of Acheson's life work which has since extended and included all the different reaction products between silicon, carbon, and oxygen. Besides the three elements we have now silicon carbide or carborundum, silicon monoxide (Dr. Potter's monox) and silica, carbon monoxide and dioxide, and the somewhat indefinite series of compounds which Mr. FitzGerald calls silico-carbides and denotes by the formula SiC_xO_y. The temperature and the other conditions of the experiment decide what the end result of the reaction will be. While from a purely commercial and industrial standpoint these products have been brought into a very satisfactory shape, it would seem that much remains to be done by physical chemists from a scientific standpoint—above all the establishment of the possible equilibria. When this is done, American physical chemists could pay their debt to Dr. Acheson by devising an Acheson diagram for the silicon-carbon-oxygen system analogous to the Roozeboom diagram for steel.

The Effect of Heat Leakage on the Electrode Losses

In commenting on Dr. Forssell's paper in our last issue, we pointed out that the phenomenon of electrode losses in furnaces may be conveniently considered as a superposition of three phenomena. These are, first, the simple heat conduction due to the temperature difference at the two electrode ends as though no current was flowing; secondly, the Joulean heat set free in the electrode, which flows off impartially one-half into the furnace and one-half into the water-jacket on the cold electrode end; and thirdly, the heat leakage from the electrode into the surrounding furnace walls, which may be considered as being sucked impartially one-half from the furnace and one-half from the water-jacket. It may be interesting to consider how the simple formulæ which hold good if the leakage from the electrode into the walls is neglected, must be changed to take account of the heat leakage. We will use the notation of Mr. Hering's fundamental article in the October issue of last year (Vol. VII, page 442). To represent the heat leakage into the wall we denote by c the circumference of the cross-section of the electrode in inches, and by w the wall leakage coefficient, defined as the mean value of the heat in watts given off per second per square inch of electrode surface to the surrounding walls. Since L is the length of the electrode, cL is its lateral surface and wcL represents the total heat leakage into the walls or the surrounding medium.

* * *

One fact is at once evident. While both the Joulean heat and the simple heat conduction due to temperature difference

depend only on the ratio L/S of length to cross-section of the electrode, but not on the length or the cross-section separately, this is not true of the heat leakage into the wall, since this depends on the circumference (but not at all on the area) of the cross-section. It would, therefore, now be meaningless to try to find that value of the ratio of length to cross-section, for which the electrode loss would be a minimum, or that value of the ratio for which no heat passes through the hot electrode end in either direction (the two temperatures and the current being given). However, if the cross-section and its circumference are given besides the temperatures and the current, we can investigate in what way the electrode loss and its accompanying phenomena change with varying length of the electrode. The heat which passes from the furnace into the hot electrode end is $jkTS/L + \frac{1}{2} wcL - \frac{1}{2} C^2 rL/S$. This becomes zero if $L = S\sqrt{2jkT/(C^2r - wcS)}$. The difference from Mr. Hering's equation is the term, $-wcS$, which is, of course, zero, if the heat leakage into the walls is neglected. Further, the total electrode loss (which is defined as the sum of the heat given off from the cold electrode end into the waterjacket plus the heat leaking from the electrode laterally into the furnace walls) is $jkTS/L + \frac{1}{2} wcL + \frac{1}{2} C^2 r L/S$, and this becomes a minimum for $L = S\sqrt{2jkT/(C^2r + wcS)}$.

* * *

As long as the leakage of heat from the electrode into the furnace walls is neglected, the condition under which the electrode loss becomes a minimum is identical with the condition of temperature equilibrium at the hot electrode end, no heat passing through this end in either direction. The above formulas show that this is no longer the case, if we take the heat leakage into the walls into account. In order to obtain temperature equilibrium at the hot electrode end, we must make the electrode longer or smaller in cross-section than would follow from the simple formulas in which the heat leakage into the walls is neglected. On the other hand, in order to make the electrode loss a minimum, we must make the electrode shorter or larger in cross-section than would follow from the simple formulas in which the heat leakage into the walls is neglected. But, after all, what we really should attempt to get is not minimum electrode loss, but rather maximum furnace efficiency. If the current, the resistance of the furnace charge, the cross-section and its circumference of the electrode, and the temperatures are given, then the condition of maximum furnace efficiency requires a greater length than the condition of minimum loss. Only when the resistance of the electrode becomes negligibly small compared with the resistance of the furnace charge, the conditions of maximum furnace efficiency and minimum electrode loss become identical.

* * *

For numerical applications, knowledge of the wall leakage coefficient w is all important, while practically no data is available. Nevertheless, we can draw in a general way the following conclusions. If we would base the calculation of the length of the electrode (cross-section, circumference, current, and temperatures being given) on the condition of temperature equilibrium at the hot electrode end, we get an upper limit for the length; above this upper limit we should not go, because we would then produce a temperature maximum somewhere within the electrode, heat flowing off from this point of maximum temperature in both directions; there would then be great danger of destruction of the furnace walls by this excessive temperature. Nor would it be wise to select exactly this length for the electrode, because any accidental rise of the current above its normal value during operation would cause the same trouble. On the other hand, if we would base the calculation of the length of the electrode on the condition of minimum electrode loss, we get a lower limit for the length, below which we should not go because we would then only increase the loss without any compensating advantages. Nor should we select exactly this lower limit of electrode length because by increasing the length above this value (by a proper amount) we raise the efficiency of the furnace as a whole. If we remain between these few limits, we cannot be absolutely wrong, and it is at least comforting to know that the value of length found from the simple formulas in which the leakage of heat into the walls is neglected, lies between the upper and lower limits just discussed.

An Interesting Blast Furnace Experiment.

Mr. Gayley's famous large-scale experiment on the use of dry blast has opened a new era in blast-furnace operation. An even more revolutionary experiment is soon to be tried in a Belgian blast-furnace plant, with not only a dry blast, but with practically an oxygen blast (as noticed in an article on new uses of liquid air and oxygen, published in this issue). Such a process has been strongly advocated in this country by Mr. J. E. Johnson, Jr. While we do not know how far Mr. Johnson's process, as described and illustrated in our Vol. VII, page 38, will be followed in the Belgian works, it will be apropos to recall here briefly his chief arguments in favor of an oxygen blast. The principal gain would be the possibility of doing away with the heating stoves for the blast and with many of the accessories. Mr. Johnson further proposes to feed the carbon and the iron ore, not together, but in separate columns. The intention is to oxidize the carbon, by the oxygen blast, to carbon monoxide and to force the carbon monoxide through the iron ore, resulting in the reduction of metallic iron and the formation of carbon dioxide. The latter passes off through the ore column and preheats it, but it does not come again in contact with free carbon. In this way more of the carbon can be oxidized to dioxide than in ordinary blast-furnace practice, and a better utilization of the calorific value of the coal can be obtained within the furnace itself. It will be interesting to watch the experiment in Belgium. In general, it is safe to say that any further reduction in the cost of producing oxygen gas will create new applications in industrial chemistry and metallurgy and will increase the demand. As an example of the interaction between different fields of activities it is peculiar that the chief impetus for the larger use of oxygen—our principal heat-producing element—should have come from the development of low-temperature (liquid air) apparatus.

A Question of Business Policy.

Managers of very large enterprises have different questions of business policy to solve which smaller firms are exempt from. When a firm or trust becomes so large or powerful

that it dominates the market supply of a commodity, the question of "fixing prices" arises; in other words, it has become master to a large extent of the law of supply and demand, in that one line. Such domination is usually based upon control of the main sources of supply and of the bulk of the machinery of distribution, in addition to the manufacturing features which are the original scope of the business. Given a firm in such a commanding position with respect to a commodity which the public needs and must buy in large quantities, be it beef or wheat, steel rails or coal oil, what are the principles which should actuate and determine the fixing of prices? Are they to be fixed at the utmost extent of the public's ability to pay, or at the reasonable limit of the company's ability to furnish?

* * *

Our business friends are familiar with the term "good-will." It probably existed on earth as a business asset centuries before "the angels sang it in." Certain it is that it is as highly valuable an asset in the balance sheet now as it ever was. Can trusts or monopolies afford to dispense with it? To come down to the concrete facts, can any firm or corporation afford to squeeze its customers to the last limit of their endurance, and thus forfeit their good-will? If an extra demand arises which causes a temporary shortage, is a corporation justified in temporarily putting up its prices, although its own manufacturing costs have not increased?

* * *

Many modern business men—the "public-be-damned" type—will answer these questions without hesitation by the simple affirmation "business is business." But, business is not business, as they mean it; it is horse-sense and common-sense and good sense applied to commercial life. The doctor who usually charges a certain sum for a certain service, and who doubles his fee because he was wanted more urgently, is not a sensible man, he makes enemies instead of friends. The shopkeeper who would charge me 10 cents for a 5-cent loaf of bread because I am extra hungry, is unprincipled, and gets no more of my future custom than I can help giving. The monopoly which "fixes prices" according to the demands of the market and not according to its cost price plus a reasonable profit, is working upon equally false and unfortunate ethical and business principles. By so doing, it is forfeiting the good-will of its customers, it invites competition, is provokes hostile legislation and stringent regulation; in other words, it antagonizes the general public good, and no business can permanently succeed upon such a foundation. A more secure business, a more permanently profitable business, a more honorable business can be built by cultivating the good-will of the public, by a "public-be-pleased" policy and by avoiding exploitation of its necessities. Short-sighted, self-willed, hard-fisted, penny-wise-and-pound-foolish some business men are, and they do not see the better way, the more honorable way—and in the end the really more profitable way, which best business sense and intuition sees and acts upon.

Two Recent Technical Advances in Steel Manufacture.

It has been said by cynical observers that patent specifications are often worded in a way so as to conceal rather than reveal their exact meaning. Nevertheless a patent, to hold good, must state the invention, and in spite of all attempts of hiding, and in spite of the many foolish things for which patents are granted, it remains true that the current patent literature contains most interesting live matter. Two quite recent instances with respect to steel making and refining are, a patent of Mr. E. Humbert for removal of phosphorus in the electric furnace, abstracted on page 48 of our January issue, and two patents of Mr. R. B. Carnahan, Jr., abstracted under Recent Metallurgical and Chemical Patents in this issue, for the production of a non-corrosive dead-soft steel of remarkable purity in the open-hearth. Mr. Humbert's patent is interesting in view of the recent statement of a very distinguished steel metallurgist that the electric furnace could do nothing new with phosphorus. It shows again how dangerous it is to argue *a priori* in such matters. To explain the new method of phosphorus removal, we may point out a certain parallelism with the method of removing the sulphur.

* * *

Sulphur in steel is chemically combined with iron and manganese. In the basic converter and the basic open-hearth these sulphur compounds will pass to a certain extent into the basic slag; and their absorption by the slag will be the greater, the higher the temperature of the slag and its basicity. But this absorption cannot be complete, as it must stop when equilibrium has been reached between the steel bath and the slag, because the sulphur compounds are soluble in both of them. The essentially new reaction which permits a practically complete removal of the sulphur in the electric furnace is the removal of the sulphur in form of calcium sulphide which is soluble only in the slag, but not in the steel bath. This seems at least the ultimate reaction in the electric furnace and because the calcium sulphide is insoluble in the steel bath, it is possible to drive the removal of the sulphur to any desired extent. If this reaction should occur in an open-hearth furnace, it could certainly not be the ultimate reaction on account of the oxidizing atmosphere which would change the calcium sulphide quickly into sulphate. This would react with the iron, causing the formation of iron sulphide which then passes back into the steel bath. It is, therefore, essentially on account of the reducing atmosphere of the electric furnace as compared with the oxidizing atmosphere of the Bessemer converter or open-hearth, that reactions eliminating the sulphur to any desired degree are possible in the electric furnace and impossible in the old metallurgical furnaces.

* * *

The removal of phosphorus in ordinary metallurgical furnaces with an oxidizing atmosphere is in the form of a phosphate. Mr. Humbert, by putting ground coke on the slag, changes the phosphate to phosphide, which is, of course, possible only on account of the reducing atmosphere of the electric furnace. It is impossible to do the same in an oxidizing furnace. The method is very simple, and, from what we have heard about its working in practice, it permits a very exact control of the phosphorus and results in a reduction in time, energy consumption, and loss of steel. The chief advantage seems to be that it is no longer necessary to scrape off the slag; this avoids much trouble and is important also for the construction of furnaces of large capacity. The electric furnace process is thus being worked out successfully in all its details and the chief problem to be solved in future seems to be to divide the whole

process of steel making into such a combination of different steps, in different apparatus, that each reaction is carried out in the most suitable apparatus (according to whether it requires an oxidizing or reducing atmosphere, etc.) and that the practical efficiency of the whole combination process is a maximum.

* * *

The patent of Mr. Carnahan for making a dead-soft, open-hearth steel, of remarkable purity, as described under Recent Metallurgical and Chemical Patents, is interesting both with respect to its method of manufacture and its properties. There is absolutely nothing electrical about the method of manufacture as it is completely an open-hearth process, but in its first part—the reduction of impurities to the desired very low degree by continuing the process much longer than is usual in ordinary open-hearth practice and thereby overoxidizing the metal—the process is just like modern practice in preparing steel in the converter or open-hearth, preparatory for subsequent refining in the electric furnace. The really remarkable feature of the process of Mr. Carnahan is that what he does with this overoxidized steel appears to be simply to reduce the oxides by ferrosilicon, and to remove the gases by addition of aluminium in the mold. It is true that his steel when it leaves the furnace is very much hotter than in ordinary open-hearth practice and this may help in the accomplishment of the ends. It is a fact that when attempts have formerly been made to refine steel thoroughly by overoxidation, failure has always resulted from the difficulties of treating the overoxidized steel. These difficulties were successfully overcome by electric furnace treatment, but Mr. Carnahan appears to have succeeded without such treatment and it is only to be regretted that the patent says so little about this most interesting feature of the process. The steel is on the market as American ingot iron and is used especially for sheets where its non-corrosive properties are of importance. The process seems to be rather expensive and it is a question whether it would not be cheaper to use a combination of converter and electric furnace processes since there seems no reason why it should not be possible to produce a steel of the same composition by such a combination.

* * *

The claim that this dead-soft steel is non-corrodible appears to have been borne out in practice as far as the comparatively short time for which this steel has been in commercial use permits to draw conclusions. If the non-corrodibility of this steel is further confirmed by experience, it will be a strong point in favor of the electrolytic theory of corrosion. It will be remembered that according to this theory, as proposed by Dr. Whitney and elaborated and expanded by the extensive work of Dr. Cushman and Dr. Walker, the intrinsic cause of corrosion must be found in the non-homogeneity of steel (due in practice to a large extent to the use of ferro-manganese); on account of this lack of homogeneity there is a liability of some places in the steel surface becomeing anodes and other places becoming cathodes, in contact with moisture which acts as electrolyte; then we have short-circuited galvanic couples and corrosion results. Evidently, if this theory is correct, then an absolutely homogeneous steel, free from impurities, slag enclosures, etc., would be non-corrodible, as has been repeatedly pointed out in these columns. The makers of "American ingot iron" work on this principle; they do not use ferro-manganese and in general endeavor to produce as pure a steel as possible. Let us hope that further experience with this steel will confirm the first good results obtained with it. It would be an indirect practical large-scale confirmation of the electrolytic theory of corrosion, and what is more important, the essential question would be definitely settled as to the direction in which we must work to find a practical solution of the corrosion troubles.

The Use of Pulsating Current for Electrolytic Refining.

It has long been looked upon as an axiom that direct current must be used for electrolytic processes. According to Faraday's law, the weight of the desired electrolytic reaction product is proportional to the coulombs passing through the cell in the proper direction. Theoretically, considering the reaction as perfectly reversible, we may conclude that by reversing the current and passing now the same number of coulombs through the cell in the opposite direction, the electrolytic reaction product of our former process is completely undone, so that at the end the system is in exactly the same condition as at the beginning. This will be true in practice, if the reaction products of the current passing in one direction remain within the zone of electrolytic action (for instance, do not pass off as gases out of the cell, etc.), and this condition will be fulfilled the more exactly the quicker the reversals of the current follow each other or, in other words, the shorter the period or the higher the frequency of the alternating current employed. In most cases of practice it is perfectly true to say that alternating current produces no electrolytic action.

* * *

The ingenious modification of the Wohlwill process of electrolytic refining of gold and gold-silver alloys, described in an article elsewhere in this issue, is exceedingly interesting, not only because it broadens very considerably the scope of the process, but because the very simple means of accomplishing this is the use of a pulsating current—a superposition of direct current and alternating current—instead of simple direct current. Everything we said above on the necessity of direct current for electrolytic action remains true in this case. The total refined gold which is obtained by deposition on the cathode equals exactly the amount which would be deposited if only the direct current were present. With respect to the output of refined gold the alternating current could just as well be absent. Why, then, is it used? Simply to break up the silver chloride layer formed at the anode, so as to avoid the necessity of mechanically scraping it off. The direct-current component of the pulsating current determines the gold deposition; the alternating-current component keeps the anode clean. In view of its remarkable practical advantages this process deserves attention far beyond the sphere of gold refining.

Lake Superior Iron Ore Values.

It would be interesting, although probably not particularly useful, to know what would have been the course of values if our Lake Superior iron-ore deposits had been discovered in a country, like England, with an old-established iron industry not subject to rapid growth on account of increase in demand. One

may well conclude that the history of prices would have been quite different from that which has been written. It was not until 1869 that pig-iron production in England passed the 5,000,000-ton mark, and not until 1906, 37 years later, that it passed the 10,000,000-ton mark. In the United States pig-iron production has doubled, on an average, just a trifle more frequently than once in 10 years. It is, of course, quite an elementary proposition that an increased demand for pig iron involves an increased demand for iron ore, and that the more rapidly the demand for pig iron increases, the more rapidly the demand for iron ore increases. There is a very marked difference, however, in the character of the demand for ore according to whether the demand for iron increases rapidly or slowly. It requires time to exploit ore deposits and develop mines to commercial production. If the increase in demand is slow, there is plenty of time to look around and develop the ore production. If the increase in demand is rapid, the time required for development becomes an important element, both because the ore is needed quickly and because, usually, rapidly expanding demand means very profitable prices, so that the ore buyer can afford to pay a premium for the quickness.

* * *

When the Mesabi range was discovered it appeared that an inexhaustible supply had been discovered, and values, as determined by the four older of the Lake Superior ranges, fell rapidly. The first Mesabi ore was shipped in 1892, contributing 4245 tons to a total output of the region of 9,082,370 tons. By the close of 1895 the range had passed each of the four older ranges in point of production, and in 1893 it shipped more ore than the other four ranges combined. For six years after values had become definitely established, or for the seasons 1894-99 inclusive, Mesabi non-Bessemer ore sold at an average price of considerably less than $2 a ton on Lake Erie docks, or at less than 50 cents at mine. Undoubtedly the industrial depression from 1893 to 1898, inclusive, had something to do with the low prices, but more in the direction of prolonging the period of low prices than in producing them. Before knowledge of the range was five years old it was certain that it contained enough ore to cover the country's entire pig-iron production, at the then obtaining rate, for 30 or 40 years. The first Mesabi ore was gained by doing little more than removing the sod. Had demand for ore increased only slowly the ore might have remained a drug on the market, but the rapid expansion in demand has made it so that stripping operations involving the removal of 75 ft. or 100 ft. of overburden are in progress.

* * *

While the greater portion of the Lake Superior ore deposits have passed to the control of consumers, there remains a large annual production by merchant interests which is sold in the open market, chiefly to merchant blast furnaces. Prices are fixed for each shipping season and do not change during the season. Ordinarily the great bulk of the season ore is sold in a few days or a few weeks. The relation between the price of ore and the prices of pig iron has undergone some remarkable changes even in the past few years, or since the general trade position of the Lake Superior ores became well established. The comparison given below is calculated to illustrate these changes. There is set down, first, the price of Mesabi non-Bessemer ore for seven seasons. Next is set down the prevailing price of No. 2 foundry pig iron, f.o.b. valley furnaces, at the time the principal ore selling was done. Next is given the average selling price of the pig iron during the approximate period of ore consumption. The year named is the year in which the ore was, or will be, shipped, the price having been named either in the early part of that year or in November or December of the preceding year, while the period of average pig-iron prices runs from May 1 of the year to May 1 of the following year.

MESABI NON-BESSEMER ORE AT LAKE ERIE DOCK, AND NO. 2 FOUNDRY PIG IRON AT VALLEY FURNACES.

Season.	Ore.	Pig iron at time.	Pig iron average.
1904	$2.50	$13.00	$13.93
1905	3.00	16.00	15.95
1906	3.50	17.25	20.28
1907	4.00	21.00	19.41
1908	3.50	14.50	14.78
1909	3.50	14.25	14.89
1910	4.00	17.00	.....

* * *

The pig-iron market has, as a rule, reflected the general state of trade rather than the cost of ore. Thus, the price of ore for the season of 1906 (which was fixed in December, 1905) was upon a market of $17.25 for pig iron, but the market advanced and from May 1 following for 12 months averaged $3 a ton higher. For the following season ore prices were fixed on a $21 pig-iron market; the market subsequently advanced to $25, in May, and declined to $15 in the following April. The actual realized price on the pig iron made from the 1907 ore was much less than is shown by the $19.41 average of quotations, for the reason that the great bulk of the pig iron was sold for forward delivery before the extreme advance occurred, the actual realized price probably being well below $19. As the price of ore is made at Lake Erie dock and the cost of transport has varied but little, the fluctuations in the price of ore at mine have been almost as large, absolutely, as the fluctuations at the point of delivery, while they have been much larger in point of percentage. What is particularly striking about the presentation given is the fact that relative to pig-iron, ore is much higher than ever before. In 1905 a $3 price was made upon $16 pig iron, but in 1908 a $3.50 price was made on $14.50 pig iron, and a year later the price was reaffirmed with pig iron 25 cents lower, while in 1906 a $3.50 price was made upon $17.25 pig iron. Again, the price of $4 was made only for 1907 and 1910, but in 1907 it came upon $21 pig iron, while for 1910 it came upon $17 pig iron. Thus with the great changes which have occurred in both ore and pig-iron prices, one trend remains distinct throughout, a higher and higher price for ore relative to the price of pig iron. The asset is the ore mine and not the blast furnace. Value depends upon the cost of replacement or duplication, provided there is need. One may readily conclude that, had there not been the rapid expansion in demand which has been experienced, values of Lake Superior ores would have remained upon a relatively low basis. As said before, for a period of six years in the nineties Mesabi non-Bessemer ore brought less than 50 cents per ton at mines. The present $4 price represents $2.50 at mines, since the rail freight from mine to Duluth is 80 cents and the lake freight through Lake Erie dock is 70 cents.

Nobel Prize for Chemistry.

The Nobel prize for chemistry has this year been awarded to Wilhelm Ostwald, of Germany. A full sketch of the life and work of Dr. Ostwald has appeared in these columns (Vol. I, page 253). Since the publication of this article Dr. Ostwald has resigned his professorship in the University of Leipzig and has also devoted a good deal of his attention to the foundation of a new system of natural philosophy based upon energy as the fundamental principle. The result has been a remarkable volume of lectures on natural philosophy. Dr. Ostwald has also just published his book, "Grosse Männer," in which he attempts to analyze the elements of scientific greatness.

Lately, however, Dr. Ostwald has again favored the chemical world with several volumes on general chemistry, chiefly emphasizing the logical evolution of chemical science and scrutinizing its philosophical foundations.

Dr. Ostwald's many friends and former students on this side of the Atlantic have heard, with great gratification, of this last honor bestowed upon him.

Chemists' Club Plans Filed.

Plans have been filed with the New York City Building Department for the 10-story clubhouse and office building to be erected for the Chemists' Club at 50-54 East Forty-first Street. It will be an artistic edifice, of white marble in French Renaissance style, of the Louis XVI period, finished with Ionic pilasters and balconies at the second story and similar decorative balconies at the top story.

The main floor will contain in the rear a large auditorium with a balcony, and the second will be fitted as a lunchroom, with social rooms opening off from it. The fourth and fifth floors will be devoted to living and sleeping rooms for the members, below which will be the library and museum. The five upper stories will contain laboratories. The building is to cost $200,000, according to the estimate of York and Sawyer, architects.

American Chemical Society.

The annual meeting of the American Chemical Society was held in Boston during the last week of December. Over three hundred members attended. As Dr. Willis R. Whitney had declined re-election to the presidency of the society, Dr. Wilder D. Bancroft, of Cornell University and editor of the *Journal of Physical Chemistry*, was chosen to succeed him in that office. Dr. Albert P. Hallock was re-elected treasurer and Professor Charles L. Parsons was re-elected secretary. Mr. Arthur D. Little, of Boston, Mass., Dr. Leo H. Baekeland, of Yonkers, N. Y., and Professor W. L. Dudley, of Vanderbilt University, were elected councillors-at-large.

The meeting was a great success from a scientific and professional standpoint. The papers and discussions were of a high order; they will all be published in full in the different publications of the Society. Dr. Whitney's presidential address on "Some Chemistry of Artificial Light" proved particularly interesting and suggestive.

The social functions of the convention were exceedingly enjoyable. Both the dinner and the smoker were well attended. At the smoker Prof. Samuel C. Prescott was the soul of Section Q. Simply to indicate the good feeling that prevailed throughout, we quote here the speeches with which seven unsuspecting scientists were presented with "honorary degrees" at the smoker:

"Harvey Washington Wiley—Doctor of philosophy, doctor of laws, food chemist of renown, genial gentleman, much maligned philanthropist. Declared by the enemies of the people to be bughouse on benzoates, accused of telling whoppers on whiskey, we honor your superb spirit, your love of truth, your bulldog tenacity in the cause of the legend, 'Pro Bono Publico' and confer upon you, sir, the degree of L.L.D., Doctor of Legal Labels.

"Arthur D. Little—Practical chemist, man of affairs, efficient organizer, we appreciate your untiring efforts as chairman of the committee of arrangements to make our brothers from other States remember the Hub. We bestow upon you the degree of C.O.D., Doctor of Chemical Organization.

"Charles Lathrop Parsons—Bachelor of science, inorganic chemist of note, famed for his exposition of the vagaries of Berrylium, consumed by a gnawing lust for numbers you have made our society the biggest in the world, we bestow upon you the degree which you so gracefully ornament, H.H.S., Hustling, Hornblowing Secretary.

"Wilder Dwight Bancroft—Bachelor of arts, author and editor. You range the field of sciences from divariant systems to cigars, from brainstorms to brass. Your famous interpretation of Gibbs is so profound that Gibbs himself could not follow your analysis. You know you are great because we cannot understand you. We bestow upon you the degree of M.S.S., Many Sided Scientist.

"Marston Taylor Bogert—Master of science, doctor of laws, the mighty wielder of unconserved language, torturer of innocent atoms. You are a past master in forcing them to roll over, sit up and beg. I confer upon you the degree of C.Q.D., Doctor of Complicated Queerazolines.

"Louis Kahlenberg—Bachelor of science, author, enemy of fanciful imaginings. We admire you as a valiant fighter in a lost cause. I bestow upon you the degree of R.I.P. ,Promulgator of Revolutionary Ideas.

"Willis Rodney Whitney—Bachelor of science, doctor of philosophy, leader of America's chemists, trained in pure science, an expert in its application. I confer upon you the degree of E.M.F., Every Man's Friend."

American Association for the Advancement of Science.

Dr. A. A. Michelson, professor of physics in the University of Chicago, has been elected president of the American Association for the Advancement of Science, for the meeting to be held the end of the year at Minneapolis, Minn. Dr. L. O. Howard, of Washington, D. C., is permanent secretary of the Association; Professor Frederic E. Clements, of the University of Minnesota, was chosen general secretary, and Professor John E. Zeleny, of the University of Minnesota, secretary of the council. Vice-presidents of the sections have been elected as follows:

Section A—Mathematics and Astronomy—Professor E. H. Moore, University of Chicago; *Section B—Physics*—Dr. E. B. Rosa, Bureau of Standards, Washington, D. C.; *Section C—Chemistry*—Professor G. B. Frankforter, University of Minnesota; *Section D—Mechanical Science and Engineering*—Professor A. L. Rotch, Blue Hill Meteorological Observatory; *Section E—Geology and Geography*—Dr. John M. Clarke, New York State Geologist, Albany, N. Y.; *Section F—Zoology*—Professor Jacob Reighard, University of Michigan; *Section G—Botany*—Professor R. A. Harper, University of Wisconsin; *Section H—Anthropology and Psychology*—Professor Roland B. Dixon, Harvard University; *Section I—Social and Economic Science*—Hon. T. E. Burton, Cleveland, Ohio; *Section K—Physiology and Experimental Medicine*—Professor F. G. Novy, University of Michigan; *Section L—Education*—President A. Ross Hill, University of Missouri.

Mining and Metallurgical Congress

The International Congress of Mining, Metallurgy, Applied Mechanics and Practical Geology, of which a preliminary notice occurred in our issue of July, 1909 (Vol. VII, page 398), will take place at Düsseldorf, Germany, during the last week of June, 1910. The congress will be divided into four sections: 1, Mining; 2, Metallurgy; 3, Applied Mechanics; 4, Practical Geology.

The presidents of the congress are Bergrat Kleine, president of the "Verein für die Bergbaulichen Interessen im Oberbergamtsbezirk Dortmund," and Kommerzienrat Springorum, director-general of the Hoesch Iron & Steel Works, and president of the "Verein deutscher Eisenhüttenleute." The general secretaries are Dr. Schrödter, secretary of the "Verein Deutscher Eisenhüttenleute"; and Bergassessor von und zu Löwenstein, secretary of the "Verein für die Bergbaulichen Interessen im Oberbergamtsbezirk Dortmund."

There will be two grades of membership in the congress. The first class of members are those who have become patrons of the congress through payment of a contribution of not less than 100 marks ($25). The second class of members is composed of those who pay a subscription of 20 marks ($5). The first-named class of members or patrons will be entitled to receive the printed reports of all proceedings of the congress in all different sections. The members of the second class, or ordinary members, will receive the reports only of that section in which they register. The proceedings of any one of the other sections will be obtainable by payment of an additional charge of 5 marks ($1.25) in each case.

The work of the congress will be performed in general meetings, at which papers of general interest will be presented, and

sectional meetings for the purpose of discussing important problems relating to more detailed fields, and by making visits to scientific and industrial institutions of interest and by excursions to districts of geological interest.

The program of Section II, that of metallurgy, is as follows:

A.—PRODUCTION OF PIG IRON.

1. Cooking.
   (a) Ovens.
   (b) Mechanical appliances.
   (c) Recovery of by-products.
2. Ore supply.
   (a) Recent discoveries of ore.
   (b) Recent development and prospects of the ore briquetting processes.
3. Metallurgy of the blast-furnace process.
   (a) Influence of foreign substances.
   (b) Composition of slag.
4. Blast furnace working.
   (a) Ore conveyance, storage and charging.
   (b) Gas washing and purification of the waste water.
   (c) Dry air-blast.
   (d) Casting machines and mixers.
5. Utilization of waste products.
   (a) Gases.
   (b) Dust from blast-furnace gases.
   (c) Slag (for hydraulic packing, cement, stone, concrete).

B.—PRODUCTION OF MALLEABLE IRON.

1. Advances in the methods of the metallurgical treatment of iron and steel.
   (a) Air blast refining process.
   (b) Open-hearth refining processes.
   (c) Processes for the production of electro-steel.
2. Production and treatment of special alloys of steel.

C.—IRON AND STEEL MANUFACTURE.

1. Improvements in the methods of casting iron and steel.
2. Further treatment of malleable iron.
   (a) Forging and pressing.
   (b) Rolling.
   (c) Fitting.
   (d) Development of the welding processes.
3. Driving of rolling mills considered technically and economically (steam, gas, electricity).

D.—TESTING OF IRON AND OTHER METALS.

1. Chemical testing.
2. Mechanical testing.
3. Metallography and microscopy of metals.

E.—ECONOMICS OF THE IRON INDUSTRY.

1. Iron trade statistics.
2. Labor conditions and labor supply.
3. Patent rights.

All inquiries for information regarding the sections or membership in them may be addressed to the Arbeitsausschuss des Internationalen Kongresses (Committee of Organization of the International Congress) Jacobistrasse 3/5, Düsseldorf, Germany.

The Institute of Metals.

The annual general meeting of the Institute of Metals was held at the Institution of Mechanical Engineers, Storey's Gate, Westminster, London, S. W., on Tuesday and Wednesday, Jan. 18 and 19, 1910.

The program contained the following papers:

C. O. Bannister, Esq., Assoc. R.S.M., on "The Use of Carbonaceous Filters in the Smelting of Zinc, as Employed in the Hopkins Fumeless Zinc Process."

G. D. Bengough, Esq., M.A., on "The Properties and Constitution of Copper Arsenic Alloys."

T. Vaughan Hughes, Esq., Assoc. R.S.M., F.I.C., on "The Failure in Practice of Non-Ferrous Metals and Alloys, with Particular Reference to Brass Loco-Tubes."

O. F. Hudson, Esq., M.Sc., and E. F. Law, Esq., Assoc. R.S.M., on "A Contribution to the Study of Phosphor Bronze."

C. A. Klein, Esq., on "Notes on a Suggested Record of Analyses."

Dr. Richard Seligman, Ph.nat.D., and F. J. Willott, Esq., on "The Analysis of Aluminium and Its Alloys."

Ernest A. Smith, Esq., Assoc. R.S.M., on "The Assay of Industrial Gold Alloys."

The first paper we print in full in this issue. Abstracts of all the other papers are included in the synopsis of Current Metallurgical and Chemical Literature in this issue.

The new Carnegie Physics Laboratory at University College, Dundee, Scotland, has been formally opened by Sir Joseph J. Thomson, of Cambridge University.

Resignation of Professor Chandler.

Professor Charles Frederick Chandler, head of the department of chemistry at Columbia University, has tendered his resignation, after forty-seven years spent in the service of that institution.

The trustees voted to accept his resignation with regret, and provided that during the next academic year he should have leave of absence, his connection with the university to expire at the end of that time. When taking action on this matter the trustees passed the following minute:

"In receiving the application of Charles F. Chandler, Ph. D., M. D., LL. D., Sc. D. (Oxon.), Mitchill Professor of Chemistry, to be relieved of active service at the close of the present academic year the trustees wish to place on record an expression of their sincere appreciation of the distinguished service which Professor Chandler has rendered to Columbia University and to the science of chemistry during his long and active career as teacher and investigator.

"Immediately upon receiving the degree of Doctor of Philosophy from the University of Göttingen in 1856, Professor Chandler entered upon his lifework of academic teaching. From 1857 until his appointment in 1864 to be Professor of Chemistry at Columbia, Professor Chandler was head of the chemical department of Union College. On his transfer to Columbia in 1864, he threw himself heartily and generously into the task of developing the newly organized School of Mines. In addition to the heavy duties of his professorship, Professor Chandler served for thirty-three years as Dean of the School of Mines, and to his effective and conscientious administration of its business that great school owes no small share of its usefulness and prestige. Besides bearing the burden of administrative and teaching duties, Professor Chandler found time for important public service during many years' incumbency of the presidency of the Health Department of the City of New York. He has also been an enthusiastic and prolific investigator of chemical problems, particularly those arising from the application of the science of chemistry to the public health and to the various forms of industrial activity. Professor Chandler is a member of the chief learned societies, at home and abroad, in which chemists are represented, and he has received well-merited recognition at the hands of his colleagues in chemistry in England, as well as in America, together with the highest honors of the University of Oxford. The chemical museum of the university, which has been built up by his efforts and in no small part by his generosity, is unique of its kind and will remain a monument to his untiring activity.

"Professor Chandler will carry with him into his retirement the affectionate regard and esteem of two generations of students, as well as of a host of colleagues on the teaching staff of the university.

"The trustees record their grateful appreciation of this long and generous career of devoted service."

During the majority of Professor Chandler's term of service at Columbia he was identified with the School of Mines, now the School of Applied Science, and was one of the three men whose efforts made its existence a possibility in 1864. At this time he was made dean of the school and he served in this capacity until the time of his resignation in 1897. While he was at its head, the School of Mines grew from a very small department of the university to one of its largest branches. Since his retirement from the office of dean, Professor Chandler has continued his work as professor of chemistry. He has taught up to the present time and will continue to do so, until the close of the present academic year.

Professor Chandler has an enviable reputation in the realm of chemistry. He was one of the leaders in the celebration of the centennial of the discovery of oxygen, which was held at the old home of Joseph Priestley in 1874. It was at this time that the American Chemical Society was organized. In 1899 the Society of Chemical Industry honored Professor Chandler

by electing him president, the first American chemist to receive such recognition.

That the School of Mines did not seem at first a very promising project is recalled in an article in the Columbia *Alumni News*. Three professors, however, were found who were willing to begin without salaries. George T. Strong, William E. Dodge, Jr., and several others furnished about $3,000 to equip the laboratory. A fine cabinet of minerals was donated by the Hon. Gouverneur Kemble, and President Barnard, Dr. Torrey, and other trustees of the college encouraged the enterprise in every possible way. Some vacant rooms in the basement of the college were assigned for laboratories. Provision was made for twelve students, but twenty-four came the first day. The success of the School of Mines was remarkable. During the entire winter the carpenters and gasfitters were constantly at work erecting new tables for additional applicants, and the number of pupils reached forty-eight.

During the first vacation a large four-story building was placed at the disposition of the school, with funds for the equipment of laboratories and cabinets. Accommodations were arranged for seventy-two pupils. During the second year the school was thronged; eighty-nine students were in attendance. The success of the new school seemed so well assured that the trustees arranged to place it on a substantial basis as a coordinate department of the college. Professor J. S. Newberry was called to the Chair of Geology, relieving Professor Chandler of this subject, and a full faculty of professors and assistants was established. A new building was erected, and equipped with laboratory accommodations for 150 pupils.

From this time on the school continued to prosper, and was from time to time expanded by the establishment of nine courses of professional study, until it became one of the most important schools of applied science in the country and acquired an international reputation. Professor Chandler was made dean of the faculty at the beginning, and was the executive officer of the School of Mines for thirty-three years. He resigned in 1897, when the university moved to its new site. During the long period of his connection with Columbia, Professor Chandler has lectured upon all branches of chemistry—theoretical, analytical, and applied. At the present time he lectures upon general and industrial chemistry, the other branches being taught by his colleagues and assistants. During the earlier years of the School of Mines the assay department was an especial hobby of Professor Chandler, and with the aid of his successive assistants he has made it the most complete of its kind to be found anywhere. To facilitate the work of assaying gold and silver ores and to insure accuracy in calculating the results, Professor Chandler devised in 1866 the system of assay weights now in general use by all assayers.

Upon the suggestion of Professor Chandler Havemeyer Hall was provided by the Havemeyer family of New York City. Preliminary to perfecting the plans of this remarkably complete institution, Professor Chandler visited and inspected every laboratory of consequence in Europe. The chemical museum, which is the personal creation of Dr. Chandler, is the most complete museum of the kind in the world, and it is unique. It gives the visitor some idea of the extent to which the affairs of man depend upon the science of chemistry.

By the resignation of Professor Chandler a serious gap is made in the instructing staff of Columbia University. A successor, and an able one, will of course be provided, but it will be difficult to find a man who will be able to act in all the capacities that Professor Chandler has served in, those of personal adviser, executive head, chemical instructor, and loyal friend.

The Iron and Steel Market.

January has been a dull month in the iron and steel trade, as was December. There has been the usual mild reaction in sentiment after a prolonged advance. Not since the great boom of 1899 had the industry experienced so important an advance in prices, and never in its history has it experienced so spectacular an increase in production, since from April to December fully 10,000,000 tons was added to the annual productive rate of pig iron.

The present reaction is purely one in sentiment, and by no means touches either production or prices. It is only human nature, perhaps, to be disappointed that further good news has not come out in the industry. The sweeping nature of the improvement in the latter half of last year had the double result of leaving no reasonable room for further improvement and of discouraging men from expecting any termination to it.

As to orders, there has been a lull, relatively speaking, for two months. These are months which are customarily quiet in the industry. No large projects are undertaken at this time and there was a particular incentive for buyers to crowd all possible business into the old year, on account of the trend of prices. There was much buying and specifying on contracts at terms which cannot be duplicated.

All signs point to the current year being one of minor fluctuations in demand, production and prices. There is no room for large swings in prices. The advance, while spectacular, was moderate, since it followed a break in prices extremely low considering the advances in costs of material and labor since the historic low prices of the middle nineties. There is no room for a great break in prices, and it can scarcely be thought there is room for a runaway market, considering the great increase in productive capacity. It strained the industry in 1907 to pass a pig iron production rate of 27,000,000 tons a year, but the present productive capacity is between 31,000,000 and 32,000,000 tons and new furnaces in course of erection will add 2,000,000 tons before the year is out.

It is not likely that there will be any great changes in total demand during the year. Production was brought up to a rate of between 31,000,000 and 32,000,000 tons of pig iron a year at the close of 1909 by a demand coming chiefly from the smaller lines of consumption, the demand based upon prosperity in the agricultural sections being most conspicuous. The consumption of steel in large projects which have to be financed was relatively light. The railroads really took very little iron and steel in 1909. While the year's production of pig iron closely approached that of 1907 and exceeded that of 1906, the railroads did not take, in cars, locomotives and rails, one-half as much material as they did either in 1906 or 1907.

It is fair to assume that a considerable portion of the demand of 1909 was for the purpose of replenishing greatly depleted stocks of material in the hands of jobbers and manufacturing consumers. This might, perhaps, point to a slight decrease in their requirements in the next few months. The industry could stand the reduction and still find itself with a much greater tonnage than at its best former rate, but at the present time the consumption of iron and steel for railroad purposes is very much greater than the average of 1909. The locomotive and car shops are running almost full, and the orders now on their books represent much more business than the actual output of the entire year 1909. Current reports are that the prospects of additional railroad buying are not good, but the business already placed guarantees a better tonnage for this year than there was last year.

Iron Ore.

Late in December Lake Superior ore interests fixed prices for the season of 1910 at an advance of 50 cents a ton over the schedule for 1908 and 1909, thus restoring the prices which were held for the single season 1907, these being $5 for old range Bessemer, $4.20 for old range non-Bessemer, $4.75 for Mesabi Bessemer and $4 for Mesabi non-Bessemer, all at lower lake dock, base guarantees being 55 per cent iron (natural state) for Bessemer ores and 51.50 per cent for non-Bessemer ores. Consumers had already made large reservations of ore, particularly of Bessemer, pending the decision as to prices, and these reser-

vations were promptly converted into actual purchases. By the middle of January more ore had been sold than in any previous year at the date. All the merchant Bessemer ore that will be brought down has been sold, and by far the major part of the non-Bessemer. A feature of the buying was that three independent steel interests, normally self supporting in ore, bought a total of about 750,000 tons of merchant ore, their purchases in previous years having been very light.

The present ore prices have not been equaled since the opening of the Mesabi range, except in 1907, but a conspicuous difference in conditions is that pig iron is from $4 to $5 a ton lower than it was when the heavy buying was done for the season of 1907. By so much has the relation between Lake Superior ore and the pig iron which is made from it changed in three years.

Vessel rates from upper lake ports to Lake Erie ports were advanced five cents from the 1909 basis, to 70 cents from Duluth, 65 cents from Marquette, and 55 cents from Escanaba. At the same time the Lake Erie docks reduced the unloading charge, which is paid by the vessels, from 20 to 15 cents, so that the vessels are in 10 cents a ton better position than last year.

Other transport charges on Lake Superior ore are unchanged. The rate from the Mesabi range to docks at the head of the lakes remains at 80 cents, this including the dockage, and this with the 70 cent vessel rate makes a total cost of $1.50 delivered through Lake Erie docks. The rail freight from Lake Erie is 56 cents to the Mahoning and Shenango valleys and 98 cents to Pittsburgh, making the total transport charge from Mesabi mine to Pittsburgh furnace $2.48, covering a distance of more than a thousand miles. The traffic, nevertheless, is quite profitable. The statement is generally credited that there is more than 40 cents profit to the Minnesota ore roads, while Lake transportation must be fairly profitable or ore interests would not have been building lake vessels in the past few years, while the rail rates at the lower end are admittedly quite satisfactory to the railroads.

Pig Iron.

Southern iron has experienced a fairly good movement in January, prices undergoing no change. In a limited way iron can be bought on the basis of $13.75, Birmingham, for No. 2 foundry, if for immediate shipment, while $14 is given for extended delivery, to July 1 and probably through third quarter. The Philadelphia market has shown a fair turnover in basic, at $18.75, delivered eastern Pennsylvania. The valley market is practically unchanged as to prices, although the tone became easier during the month. Basic and No. 2 foundry are available at $17, valley furnaces, for first quarter, and at $17.25 for extended delivery. Bessemer remains firm at $19, valley, although quiet. Buffalo has shown the lowest prices at northern furnace, $17 being shaded rather freely.

Steel.

The tone of the unfinished steel market has been slightly easier. Sheet bars are available at $29, maker's mill, Pittsburgh or Youngstown, for extended delivery, and occasionally odd lots are offered at a slight concession. Billets may be roundly quoted at $27.50 for Bessemer and $28 for open-hearth, Pittsburgh. Wire rods are very quiet at $33, Pittsburgh. A comparatively easy market for unfinished steel is to be expected, as the pressure for delivery of finished material is not equally distributed among the different finished lines.

Finished Materials.

There has been no definite trend in prices of finished steel products. Merchant steel bars, which were available in December in a limited way at $1.45, Pittsburgh, although the general market was more fairly quotable at $1.50, have been firmly on the basis of $1.50 since the first of the year. Hoops are likewise slightly higher, being quotable at $1.60 to $1.65. Other finished steel products are unchanged. The market is quotable as follows, at Pittsburgh unless otherwise noted:

Standard steel rails, $28 for Bessemer, $30 for open-hearth, f.o.b. mill, except Colorado; light rails, 40 and 45-pound, $27.

Plates, $1.55 for tank quality, ¼-in. and heavier.

Shapes, $1.55 for beams and channels, 15-in. and under, zees and angles 2 x 3 and larger.

Steel bars, $1.50, base.

Iron bars, $1.65, Pittsburgh; $1.60, Philadelphia; $1.55 to $1.60, Chicago.

Wire nails, $1.85, base; plain wire, $1,.65; galvanized barb wire, $2.15.

Black sheets, 28 gage, $2.40; galvanized, $3.50; blue annealed, 10 gage, $1.90; painted corrugated roofing, $1.70 per square; galvanized, $3.

Tin plates, $3.60 for 100-lb. cokes.

CORRESPONDENCE.

Silundum.

To the Editor of Metallurgical and Chemical Engineering:

SIR:—In your issue of December, 1909, in which is contained the report of the meeting of the American Electrochemical Society, I find the paper on "Silundum," by Prof. S. A. Tucker, and I regret to say that I am incorrectly reported as follows:

"Dr. Acheson remarked that silundum was nothing new; it was the same product that he had called siloxicon." So near as I now remember what occurred was as follows: The president invited me to open the discussion following the reading of Professor Tucker's paper and I made these remarks: "Mr. President, you will kindly excuse me from entering into a discussion of this matter. From what I had formerly heard regarding silundum I was under the impression that it was a compound of carbon, silicon and oxygen, and was, therefore, the compound which I have designated as siloxicon. Since hearing the reading of Professor Tucker's paper, I now appreciate the fact that there is no oxygen present."

My reason for asking to be excused from entering into a discussion of the product as produced by Mr. Bölling was due to the fact that Mr. Bölling was formerly my assistant, he having entered my employ, I believe, in the latter part of the year 1893, while I was still at Monongahela City, and he went with me to Europe as assistant engineer in 1894, and I returned to this country leaving him abroad.

In the active zone of the furnace, as I understand it is operated by Mr. Bölling, there are three elements which may react on each other, viz., carbon, silicon and oxygen. In analyzing the possible reactions and the products that might be obtained from these three elements we find that the furnace content may be so proportioned and the furnace so operated as to produce either graphite, metallic silicon, carborundum, or amorphous carbide of silicon (as made by P. Schützenberger and described by him in a communication to the Academy of Science of France, May 16, 1892), or we may have all the three elements so associated as to produce siloxicon. As to the possibility of any other product being made, I am not advised, but the foregoing were old before the world was informed of Mr. Bölling's experiments.

NIAGARA FALLS, N. Y. E. G. ACHESON.

To the Editor of Metallurgical and Chemical Engineering:

SIR:—In the December issue, 1909, I find an account of an American Electrochemical Society paper on silundum by Prof. S. A. Tucker, H. F. Kudlich, and E. M. Heumann, and in the discussion of this paper a statement of Dr. Acheson that silundum was nothing new; that it was the same product which he had called silixicon.

I must contradict Dr. Acheson and I claim the priority of the discovery of this new material and of the fact that silicon vapors penetrate into carbon, when both are in a highly heated state, converting the carbon into a refractory, electrically conducting material, of a composition with varying proportions of

silicon and carbon. Silundum, therefore, as described in my paper, published in this journal, January, 1909, in form of rods, tubes, crucibles, or any other shape made of carbon, is new. The date of my first German patent is April 24, 1904, and I started experimenting October 31, 1903.

Silundum is used now in Europe for various purposes, especially for electric heating purposes. It is manufactured by the Chemisch Elektrische Fabrik Prometheus in Frankfurt.

Oberwesel, near Frankfort, Germany. F. Bölling.

Iron-Copper Alloys.

To the Editor of Metallurgical and Chemical Engineering:

Sir:—I have read with considerable interest the abstract of Charles F. Burgess' and James Aston's paper on "Iron-Copper Alloys," published in your December issue (Vol. VII, page 527), and believe that the following points are of sufficient importance to bring to the attention of your readers. In the preface the following statement is made:

"The influence which copper has in iron and steel has for long been a subject of controversy and contradiction. It is only comparatively recently that the effect has been investigated systematically and some of the doubt eliminated.

"The prevalence of appreciable quantities of copper in the ores of certain districts makes important a knowledge of its effect, detrimental or otherwise, when present in small amounts. Also the intimate relation of copper, nickel and iron, and the beneficial effect of the addition of nickel to iron and steel, creates an interest in the influence of larger percentages.

"The older opinion was that copper was deleterious; that its chief effect was analogous to that of sulphur in that it rendered iron red short and destroyed its welding power. This view was taken by many eminent metallurgists, some even contending that 0.5 per cent makes steel worthless. Others claimed that the influence was greatly exaggerated, and instances were cited where rolled sections of 0.50 per cent to 0.75 per cent of copper did not display red shortness."

With this statement, the authors proceed to manufacture the alloys, using pure iron and pure electrolytic copper, and while the abstract of the paper does not so state, I judge that the alloys were made from these materials, using the crucible to melt the same. In the manufacture of crucible steel the base materials are melting bar which is obtained by puddling, rolling and rerolling; blister bar obtained by carbonizing the melting bar, and "medicine." This latter consists of black oxide of manganese, clay and any of the ferro-alloys which may be required to produce the kind of steel.

The base material in the crucible manufacture is, therefore, practically wrought iron, which would be free from any copper that might have been contained in the ore from which it came. The puddling and reworking operations would have completely eliminated the copper with the slag, so that it is quite safe to say that no crucible steel contains copper except that intentionally added or introduced with the alloys. Furthermore, crucible steel is the highest grade of steel and is made from selected bar iron, which is usually made from the highest grade of ores and these are free from copper.

These base materials are charged into a pot and protected from the air by a cover and the slag, so that the steel is made in practically a closed receptacle away from all oxidizing influences. Therefore, the resulting product is quite free from all oxides and therein to a large measure lies the superiority of the crucible steel. It would follow that the alloys manufactured by the authors would be the freest from oxides, and have been produced by a process which is never used in the manufacture of steels in which copper from the ores is likely to be found.

The writer believes that the oxide or suboxide of copper is the real cause of the red shortness which is characteristic of the steels containing copper; and all of such steels are the product of the open-hearth or Bessemer processes. In both these processes there is every chance for the formation of an oxide of copper since these steels contain, in comparison to the crucible steel, considerable quantities of the oxide of iron, silicates, etc.

The quantity of the oxide is largely dependent upon the composition of the steel; for instance, that steel low in carbon and manganese is usually found to contain more oxides since the oxidizing action has been carried to a greater degree. Furthermore, the steel made in the basic open-hearth furnace usually contains more oxide than acid open-hearth steel. In the latter process the basic oxides combine with the acid slag and are more readily eliminated from the steel.

Hence, it follows that the amount of copper permissible in open-hearth or Bessemer steel, without the production of red shortness, is of variable amount depending upon the composition of the steel, the degree to which it has been subjected to an oxidizing reaction, and the degree to which the oxides formed by the oxidizing reaction have been eliminated from the steel.

In other words, the degree of red shortness produced by the presence of the copper is dependent upon the conditions of the manufacture and the other elements in the steel. My experience has shown that when the carbon and manganese are low (carbon less than 0.10 per cent, manganese less than 0.12 per cent) the presence of 0.5 per cent of copper produced a decided red shortness. The photographs of some hot rolled steel, herewith reproduced, speak for themselves, showing how the material acted under the rolls. That on the right is higher in manganese by 0.06 per cent and contains less copper. It rolled out very well, showing no red shortness. That on the left is higher in copper and lower in manganese. It showed decided red shortness, as the photograph indicates.

HOT-ROLLED STEEL.

The paper by Messrs. Burgess and Aston is a very good one and quite interesting, but the preface does not seem to me to be quite in harmony with the work which they have done. The two together give an erroneous impression, and the comment made by Dr. J. W. Richards in the discussion (that much of our steel contains copper, from 0.5 to 0.7, that it has been claimed privately that the copper is not injurious, but rather beneficial and that this has now been established by Professor Burgess) would seem to me had been made while under the influence of this wrong impression.

I trust that I have made my remarks sufficiently clear so that the points, which I wish in particular to bring out, will be understood.

Reading, Pa. Geo. W. Sargent,
Metallurgist, Carpenter Steel Company.

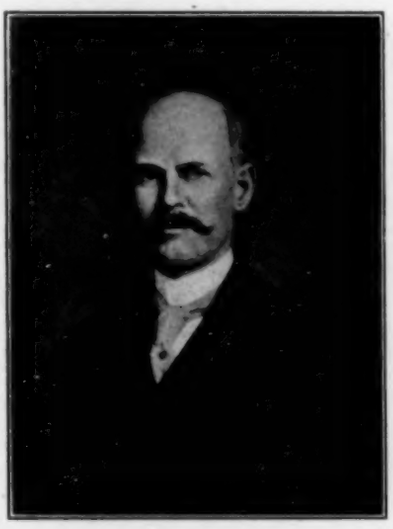
The Presentation of the Perkin Medal to Dr. E. G. Acheson.

At the meeting of the New York Section of the Society of Chemical Industry, held at the Chemists' Club on Friday, Jan. 21, the Perkin medal was presented to Dr. EDWARD GOODRICH ACHESON, of Niagara Falls. In spite of the inclement weather the meeting was well attended, not only by members of the Society of Chemical Industry, but also by members of the American Chemical Society and of the American Electrochemical Society, Dr. Acheson being a past-president of the latter society.

Mr. MAXIMILIAN TOCH, as chairman of the New York Section of the Society of Chemical Industry, referred in his introductory remarks to the presence of so many who had come from a distance to attend this meeting, and said that "it is seldom given to any man that, when his work is successfully crowned, it be done in the presence of so many prominent scientists. We are assembled to-night to do honor to our fellow-member, Dr. Edward Goodrich Acheson, to present to him the Perkin medal, which originated practically in this hall four years ago. It will always be a credit to the Society of Chemical Industry that the first Perkin medal was presented to Sir William Henry Perkin himself, and many a brilliant gathering has taken place here, but none more brilliant than that at which we are assembled."

Mr. Toch also said that "although Dr. Acheson's name has been linked for many years with the invention of artificial graphite and carborundum, still those of us who have watched his scientific career more closely have, like myself, been most interested in the work he has done in colloid chemistry."

Mr. Toch then called upon Dr. Charles F. Chandler to present the Perkin medal to Dr. Acheson.



E. G. Acheson

Address of Presentation.

Dr. C. F. CHANDLER spoke as follows:

"It is my pleasant duty, as the senior past-president of the Society of Chemical Industry in this country, to present to Dr. Edward Goodrich Acheson the fourth impression of the Perkin medal.

"Dr. Acheson possesses the rare merit of combining the inventive, the constructive and the organizing faculties. He has been most successful in discovering entirely new materials suitable for a great variety of purposes which have become indispensable to the world. He has also been able to devise the most perfect methods and appliances for producing his new products on a large scale, and he has been able to organize and finance great companies to put his inventions into successful operation."

Dr. Chandler outlined briefly the early life of Dr. Acheson (see our Vol. I, page 90), and then spoke at greater length on the chief inventions of Dr. Acheson, as follows:

"Carborundum."—In 1886, while making some experiments, he passed a quantity of hydro-carbon gas over highly heated clay and observed that the clay became impregnated with carbon. In the early part of the year 1891, having at his command an electric generating plant of considerable capacity and looking about for a line of experiments, he thought to try the impregnating of clay with carbon under electric heat. The mass resulting from the experiment exhibited a few small crystalline specks. These he carefully examined and found that they not only scratched, but actually cut glass. They appeared like minute gems. Grasping the possible value of his discovery, he undertook further experiments and after two months' labor succeeded in obtaining a few grams of crystals. In order to test their value as an abrasive, he mounted an iron disk in a lathe, charged its surface with his new unknown product and found that this revolving disk cut the polished face off a diamond.

"Having satisfied himself of the abrasive quality of his new product he took it to a diamond cutter in New York, who tested it, and was glad to buy it at 30 cents per karat; and with the proceeds of this first sale Acheson purchased a microscope to assist in the further study of the material. Having thus obtained this material from clay and carbon, and not yet knowing its chemical composition, he gave it the new name 'carborundum,' but he soon learned that it was the silicon of the clay, and not the alumina, which united with the carbon, producing a carbide of silicon, but the name 'carborundum' has been retained for the substance ever since.

"In 1894 he established the Carborundum Company at Monongahela City, Pa., but subsequently moved to Niagara Falls, where he finally erected works and equipped a plant with 5000 electric horse-power and where he has manufactured more than 7,000,000 lb. of carborundum.

"Time will not permit me to enumerate the various uses to which this new abrasive substance was applied. Suffice it to say that nearly 600 men are employed in the works at Niagara Falls in preparing carborundum and fashioning it into wheels, sharpening stones, hones, bricks, knife sharpeners, paper, cloth, etc., fitting it for every kind of abrasive application. I should not omit to say that carborundum has proved a special substitute for ferro-silicon in the manufacture of steel.

"Artificial Graphite."—In the carborundum furnace Acheson noticed that in the hottest zone, next to the carbon core, there was produced between the core and the carborundum crystals a thin layer of graphite, which he decided must be produced by the dissociation of a portion of the carborundum and the expulsion of its silicon in vapor. The discovery led Acheson to make a long series of experiments, the result of which was the discovery of a process for converting amorphous carbon, such as coke or anthracite, into beautiful artificial graphite. As a result the International Acheson Graphite Company was organized and large works were erected for the manufacture of artificial graphite. This company turns out several million pounds of what is termed bulk graphite made principally from anthracite coal.

"Graphitized Electrodes."—In addition to the bulk graphite, shapes suitable for electrodes are prepared, and by subsequent exposure to the proper heat in the electric furnace, they are converted into graphite, hard and compact. These graphitized electrodes have proved of the utmost value in various electrolytic operations, as they are found to be many times more suitable than the carbon electrodes previously used. The company manufactures several million pounds of these graphitized electrodes annually.

"Soft Graphite."—The artificial graphite produced by the International Acheson Graphite Company was hard and well suited for use as electrodes for electric furnaces and electrolytic cells and for many other purposes. In 1906 Mr. Acheson devised a process for producing a soft graphite. This graphite is especially valuable for use as a lubricant, a stove polisher, coating electrotype molds, etc. This graphite is not only pure and soft, but unctuous, and does not coalesce when compressed.

"Deflocculated Graphite."—In investigating different clays in connection with the manufacture of artificial graphite crucibles Mr. Acheson's attention was called to the great difference in the plasticity of various clays, and especially to the fact that clays far removed from their place of origin were most plastic,

and the idea came to him that this might be due to the fact that in their transportation by water they had become impregnated with vegetable extracts which might increase their plasticity. With this idea in mind, he conducted a series of experiments with various clays and discovered that by treatment with tannin the soft graphite is so modified that it remains suspended indefinitely both in water and in oil, and he immediately realized the importance of the discovery, as enabling him to supply the world with a new lubricating agent invaluable in all purposes where lubricants are required. The value of this discovery is best shown by the fact that a shaft can be run from 50 per cent to 100 per cent faster with oil containing deflocculated graphite than with the plain oil.

"Siloxicon."—In the latter part of the summer of 1899 Acheson became interested in the direct reduction of silicon, and among other experiments he mixed graphite and silica, and exposed the same to the electric current with a view of producing silicon. He produced in this way a peculiar product which he found to be highly refractory. Analysis showed it to be composed of silicon, carbon, and oxygen, hence the name siloxicon. A special company was organized for the manufacture of this interesting product and for producing from it such articles as crucibles, muffles, bricks, etc.

"It is impossible in the short time allotted to me to give anything like an adequate account of all of Dr. Acheson's achievements. Nor it is even possible to give a full account of any one of them. But I have said enough to make it clear that Dr. Acheson is an inventor of the first order—a thorough electrician and a thorough chemist. His efforts have not been directed merely to improving processes and products previously known. He has made entirely new departures and created new industries, supplied previously unknown materials for use in the arts and industries, and he has discovered uses for his new materials and processes for their application. He is a representative electrochemical engineer, and it is eminently proper that he should have been selected by the great chemical societies of this country to receive the Perkin medal.

"It gives me great pleasure, Dr. Acheson, as the representative of the Society of Chemical Industry and the affiliated chemical and electrochemical societies, to place in your hands this beautiful token of the appreciation and affection of your fellow-chemists."

The Dawn of an Electrochemical Epoch.

Dr. E. G. Acheson replied as follows:

"It was a coincidence of more than ordinary importance to me that I first saw the light of this world in the spring of 1856—the very year made memorable by the great discovery of the dye stuff 'mauve' by Sir William Perkin. During my childhood and early manhood occurred the development of most of the great chemical and metallurgical industries with which we are now so familiar.

"In the last quarter of the nineteenth century the world was ready for another step forward in the chemical arts. It was ripe for the birth of a new industrial chemistry, until then unknown—industrial electrochemistry. I believe this birth occurred at the time of Hall's work on aluminium. The great movement for the conservation of our natural resources calls into action a vast amount of work that properly will fall to the chemists of all lines of industry—more especially the electrochemists. Their field of research and development will be practically limitless and will extend beyond what the world is now considering the conservation of natural resources, for they will create valuable products from wastes not now dignified by the title of resources—a field largely devoted to synthetic work.

"I wish to thank you and the societies which you represent for the great honor you have conferred upon me, and I have no greater or more sincere desire than that my work may, in a small way, stimulate the rapid expansion and development of synthetic electrochemistry which will result in a great **electrochemical epoch,** following the chemical era brought to life by the illustrious scientist in whose honor this medal was created."

Dr. Acheson then entered into a description of some of his more recent work on deflocculated graphite, aquadag and oildag. He spoke in an informal way and illustrated his remarks by exhibits and various experiments. It was exceedingly interesting to follow in detail the various steps of discovery, speculation, and invention by which Dr. Acheson finally realized what he prefers to call "deflocculated graphite," or graphite in the colloidal state.

A Classic for Children and an Inspiration to Chemists.

Dr. Wilder D. Bancroft, of Cornell University, then spoke as president of the American Chemical Society, as follows:

"On an occasion like this it is an honor to represent anything. It is a great honor to represent the American Chemical Society. There is a personal reason why it is an especial pleasure to me to be one of the speakers on the particular evening on which the Perkin medal is awarded to Mr. Acheson.

Most of you can remember the time when physical chemistry was looked upon as a fad, interesting enough, but purely theoretical. Some of us preached in season and out of season that a proper training in physical chemistry was the ideal training for an industrial chemist. We were looked upon as harmless maniacs and consequently were not ill-treated. It did not do any good for us to talk like that unless we could prove it—and there was always the painful possibility that we might be wrong.

"I do not wish to claim for Mr. Acheson that he was the first manufacturer to employ a physical chemist at a good salary. I am always hazy on the subject of dates, but I imagine that that honor belongs to the General Electric Company. Mr. Acheson was the first manufacturer, however, who was rash enough to try the Cornell product.

"Once the ice was broken everything went well. So far as I know, the properly trained physical chemist has always made good in industrial work. You remember the French proverb: 'Ce n'est que le premier pas qui coute,' which may be rendered into the vernacular as 'It is only the first year that you don't earn your salary.'

"A man who receives the Perkin medal is expected to have made several great inventions. That has been the case so far, and, from what I know of American chemists, the supply is likely to hold out for many years to come. There is a great difference in the work of different inventors when considered as an artistic whole. From a pictorial point of view their inventions may often be said to be spotty; they are determined by business exigencies, or they are like lightning, which is said never to strike twice in the same place. I have never tried the experiment.

"Take our friend Baekeland, for instance. He is after me tonight, but I am after him now. He has made two great inventions. Velox is one and bakelite is the other. There is no visible connection between them, and there is no fundamental reason why they should have been made by the same man. They are individual outbursts of genius.

"Take the first man to whom the Perkin medal was awarded, Mr. Herreshoff. I remember that Dr. Chandler cited as two of his inventions improvements in the series system for refining copper electrolytically and improvements in the contact process for making sulphuric acid. Copper sulphate is the electrolyte used in the electrolytic refining of copper and it is made from sulphuric acid; but these are really separate inventions. So far as I can see the only thing which they have in common or which holds them in common is the General Chemical Company.

"If we do not limit ourselves to the field of chemistry everybody will admit that Mr. Edison is the greatest of American inventors. He converted electrical energy into light in the case of the incandescent lamp; he converted electrical energy into sound in the case of the phonograph or gramophone, whichever it was that he invented; he converted chemical energy into

electricity in the case of his storage cell. These inventions hang together in a very satisfactory way; but how are you going to fit in his invention of monolithic cement houses for the poor?

"In the case of Mr. Acheson there is a logical sequence about his inventions which delights the soul of any one like myself who lectures on applied electrochemistry. Mr. Acheson invented carborundum. The carbon in the cone of the furnace changed partially to graphite and he worked out a method for preparing graphite on a commercial scale. On the outside of the carborundum layer there was a ring of 'white stuff' as it was called, and Mr. Acheson organized a company to manufacture siloxicon. There were lumps of silicon throughout the carborundum and a former assistant of Mr. Acheson, Mr. Tone, worked out a process for making silicon, thereby giving the commercial world a new element. Everything in the carborundum furnace has been worked into an industry with the exception of the unchanged charge and that they use over again, so that it is not wasted.

"If Mr. Acheson will forgive me for slurring over the distinction between discovery and invention, I should call him the Swiss Family Robinson of chemistry. You remember the book. The shipwrecked family went out to search for food, and they discovered a bread-fruit tree with sandwiches growing on it. They came to a stream and they invented a cantilever bridge which they constructed with the aid of a bow and arrow and a dog. They discovered or invented a palm tree with cocoanuts growing at the top. In order to get the cocoanuts they invented or discovered a shark stranded in the shallows; they made gaiters of his skin and climbed the tree. Now nature had intended the cocoanuts to be blown off the tree, and when they were brought down by hand it at once became a problem how to open them. Our friends thereupon discovered or invented a crab which inserted the points of its claws in the holes of the cocoanut and spun a yarn which broke the shell and enabled them to get the milk in the cocoanut.

"The analogy with the work of Mr. Acheson is obvious. He began by trying to make diamonds. He denies this, but the myth persists in spite of him. When the crucible was opened there were no diamonds but instead a mass of multi-colored jewels. When he discovered that they were not real gems it was a crushing blow and so hard that he decided to use them as an abrasive. To make carborundum he needed electrodes, so he invented graphite. A suitable refractory was needed to keep the heat in the furnace, and Mr. Acheson thereupon prepared siloxicon. The furnace had to have brick walls at first, and they were promptly forthcoming in the form of Egyptianized clay. In order to keep everything running smoothly, including the three automobiles which he had acquired in the meantime, Mr. Acheson prepared the lubricating graphite which he has shown you to-night as aquadag and oildag.

"When you stop to think of him, Mr. Acheson's work is really a classic for children as well as an inspiration to chemists. He has revolutionized many branches of chemistry and he has revolutionized the whole of electrochemistry. I should like to say a good deal more about this last, but I should play havoc with Baekeland's typewritten speech if I did.

"You may consider Acheson's discoveries as scientific inventions or as dividend payers; you may even look at them in a flippant way. It makes no difference. They stand all tests and they stamp him as one of the great inventors of the world.

"I am speaking to-night for the members of the American Chemical Society, forty-five hundred strong at Christmas, and probably five thousand now unless Parsons has been taking a vacation. In the name of the American Chemical Society I congratulate you, Mr. Acheson, upon the honor which you have received to-night and which you have so richly deserved."

Pathfinder, Conductor, Switchman—Everything.

The last address of the evening was made by Dr. L. H. Baekeland, as president of the American Electrochemical Society. Dr. Baekeland said:

"What is more to the credit of Dr. Acheson than anything else is the fact that he undertook experiments which probably had been attempted several times before without success by people who had more theoretical preparation than he. But his unusual keenness of observation, his commonsense logic, and more than anything, his appreciation of what was of preponderant importance and of secondary interest, brought him results where others had failed and by which he opened a new field of chemical investigation and industrial applications.

"Dr. Acheson stands as a living example to many a chemist, loaded with theoretical knowledge and paper wisdom and light in judgment or common sense. He entered into a new road with very little knowledge to go by, but he had an open mind, a fertile brain, a constructive purpose, and all the talents of the tireless, intelligent experimenter; his theoretical knowledge he made himself, or picked it up by and by along the road he was pursuing, while he himself was building that road. Whatever he took up, he started from the very beginning and developed it to the very end.

"His very insuccesses he turned into practical channels, to change them into victories. He started his work on carborundum by an experiment so simple and so meager in results that few people, if any, would, like himself, have found in this a spur to further investigation. Later on, when in the manufacture of carborundum, he had to battle with irregularities due to a partial dissociation of the silicon carbide, which thus spoiled his product, he tried by a more powerful action of heat to carry this dissociation to the extreme limit; he so created a new industry, the manufacture of artificial graphite. In the same way he turned irregularities due to oxidation or partial reduction into a new field of study and research and gave us siloxicon, a product which seems to have a considerable future in store.

"I shall not attempt to describe here the history of the work of Dr. Acheson. He himself, in a memorable address delivered in Boston before the American Academy of Arts and Sciences, when the Rumford Medal was awarded to him, has given us a most fascinating account of this subject, and to those of my fellow chemists who have not read his 'Seventeen Years of Experimental Research,' I can recommend it as an inspiration.

"Never did the University of Pittsburgh award an 'honoris causa' degree to a more worthy man than when the doctor's degree was conferred upon our distinguished friend.

"In the making of the great road of industrial progress, very few of us are path-finders; some are surveyors, other ones constructors, others, again, are merely switchmen, brakemen and conductors. Dr. Acheson not only was a path-finder, but he has been constructor, conductor, switchman—everything. By his manifold abilities and good judgment he has been able to develop his discoveries to the point where they became a commercial success. He has shown us that an inventor or a scientist does not have, necessarily, to be a theoretical dreamer, unfit for executive or practical work.

'Dr. Acheson has another great claim of recognition upon us; successful as he has been in his enterprises built on the result of his inventive genius, he has never ceased to make us feel that he was near to every one of us. He always taken an active part in the work of our chemical societies, where his presence and his papers have stimulated many of us younger in experience or less successful in our efforts. In many instances he has allowed our chemical societies to inspect the plants where his industrial processes are carried out, and he has never hesitated to publish the results of his research work. He has thus set a praiseworthy example to such of our manufacturers who try to insure by uncompromising secrecy and seclusion the money-making end of their enterprise.

"Dr. Acheson, in the name of the American Electrochemical Society, I congratulate you on this recognition of your splendid work, and I congratulate the Perkin Medal Committee just as much in their choice of you."

All speakers were applauded with considerable enthusiasm.

Treatment of Ore Slime.*

By Andrew F. Crosse.

The chief difficulty in treating slimy material with a cyanide solution is the difficulty of removing and obtaining the dissolved gold, or silver, from the slime. Many methods have been tried, and the methods chiefly in use to-day are the well-known decantation process and various filter-press processes. The decantation is very slow, and, therefore, requires an enormous plant, and a very large quantity of solution has to be handled in proportion to the weight of slime treated.

The filter-press method has many advantages, but it requires much handling and constant renewals. In my process the slime, having been collected in a suitable manner, is washed with a weak cyanide solution into a conical treatment vat. This vat is provided with an interior conical baffle, open at the bottom, and reaching about half way down the treatment vat. Inside the vat is a pipe extending, from nearly the bottom of the cone, to a foot or two above the surface of the pulp. This pipe has a small pipe introduced at the lower end, through which air is forced; this causes a current of concentrated or thickened pulp to be forced up the tube. At the same time the clear liquid, in the outer portion of the conical vat, is overflowing into the zinc box where the gold and silver are deposited, and then this clear solution, deprived of its gold and silver, is pumped by a small pump, which can be regulated as to speed, back into the top of the inside cone, where it mixes with the underflow brought up by the air-lift pump.

By this means the whole mass is kept in continuous circulation under the most advantageous condition for the solution of the gold or silver. As the air circulates and aerates the pulp, the gold and silver are being continually extracted from the solution. The same solution acts as a wash, practically all the gold and silver having been extracted and deposited in the zinc box. During the working of the process it is very easy to control the strength of the cyanide solution or the alkalinity, and should either be found too low more cyanide or alkali can be added.

Clear solution containing gold is passing through zinc boxes and depositing its gold in every cyanide plant. The circulation of cyanide solution and slime by means of an airlift pump is quite the ideal method of solution, as I have proved in hundreds of trials. Most gold ores produce on crushing a certain proportion of real slime, which is usually a hydrated silicate of alumina with an excess of silica, or a very finely divided hydrate of ferric oxide and finely ground pyrites.

Metallurgists all recognize to-day that no hydro-metallurgical gold treatment can be successful unless the ore has been sufficiently finely crushed in order to render every particle of gold or silver accessible to the solvent action of the cyanide solution. In order to carry this out tube mills, pans and other devices have been introduced, so that a large proportion of the crushed ore cannot be treated by percolation.

In my scheme I can handle any fine material, and I can treat successfully either ordinary argillaceous slime, fine sand, or finely ground pyrites. I have treated a highly ferruginous slime and obtained an extraction of 93.2 per cent of the gold contents from slime containing 7 dwt. fine gold per short ton. This means that the gold so obtained was precipitated on the zinc. This same slime was treated by a filter-press plant, and only gave extraction of 61 per cent of the gold; this was owing to the nature of the slime, as it contained so much ferric hydrate, and it was impossible to wash out the dissolved gold from the pressed slime.

The cost of erecting a plant according to my plan would be very much less than any other that I know of, as it merely requires the ordinary conical vats, pipes for air-lift pumps, zinc boxes, and an air compressor. The mechanical efficiency of an air-lift pump is quite equal to other pumps for slime pulp as the proportion submerged is very large in proportion to the actual lift required. Very little labor is required to run the plant and one attendant could look after several vats.

As regards the strength of the cyanide solution and consumption of chemicals, that would depend on the nature of the ore and would be neither more nor less than that required by other methods.

My plant (see Fig. 1) consists essentially of a conical vat *A* having within a cone-shaped baffle *B* and a pipe *C*, up which a jet of air is directed from the small pipe *D*; a further pipe *E* leads from near the top of the vat *A* into the zinc precipitating box *F*, which is provided with a pipe *G*, through which a small air-lift pump *H* returns the liquor from the zinc box to the inside of the baffle *B*.

The method of operating the plant is as follows: The slime, having been collected by any suitable method and the excess of

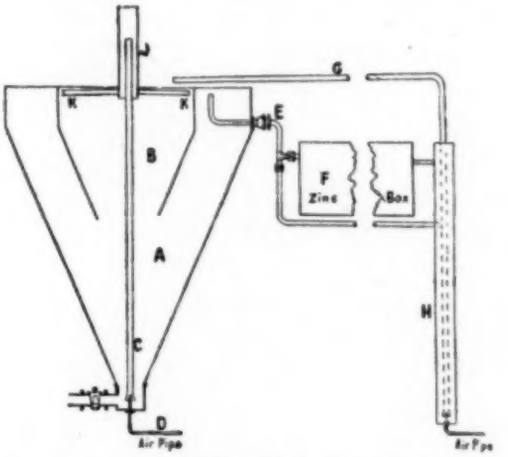


FIG. 1.—SLIME FILTRATION PLANT.

water decanted off, is washed by means of a weak cyanide solution into the treatment vat *A* through the baffle *B*. Further weak cyanide solution is then added and air turned on through the pipe *D*. This forces up through the pipe *C* into the receiver *J* a mixture of slime, dilute cyanide, and air to a point a foot or two above the level of the liquor in the vat *A*, to which it returns through the pipes *K*, which are so arranged as to give their discharge a circular motion within the baffle cone *B*.

The slime then settles down continuously, reaching the bottom of the cone in the form of a thickened pulp, and is again lifted through the pipe *C*. The pulp occupying the space between the baffle cone and the wall of the cone *A* is in a state of comparative quiescence, the only movement being a gentle flow upward of the enriched solution to the pipe *E* on its way to the zinc box. The conical shape of the vat *A* reduces the rate of upward flow and insures that the top few inches of liquor are clear and free from slime, and thus are in a fit state for precipitation. The solution deposits its gold content in the zinc box and is then returned by the pump *H* to the inside of the baffle, where it continues its work, and the sequence above described is allowed to proceed until a large proportion of the gold has been precipitated.

Having described my slime process, I would now like to go into further details.

I have made a considerable number of experiments as to replacement of the solution when the pulp is being agitated in the conical vat as described. The method I used was to have a weak chloride of sodium solution and no cyanide. I found that with the vat constructed as shown in the diagram and having a pulp containing 20 per cent of dry slime, or 1/5, I could obtain a clear overflow of 18 per cent of the contents of the conical vat per hour, and that when a volume of solution equal to the solution in the vat had been replaced by water running into the

*A paper presented at the annual general meeting, held in November, 1909, at Johannesburg, Transvaal, of the Chemical, Metallurgical and Mining Society of South Africa.

inner cone *B* that 75 per cent of the chloride of sodium had been removed. I obtained this result several times with different slimes, both in London and in the Transvaal. The same thing happens with gold and silver in solution, and as the solution, when it is returning from the zinc box, pours into the inner cone the gold-bearing solution is taken off by the decanting arm as described.

I want to call attention to one point. In beginning the operation with a solution not containing gold, the upper portion of the solution which begins to overflow would not obtain any gold for some time and it would be useless to pass it through the zinc box; therefore, in working this process I would recommend circulating for about two hours before allowing any overflow to take place. This is very easily arranged, as the pulp in the inner cone *B* is concentrated and has a much higher specific gravity than in the outer portion, the surface of the liquid is several inches below the level of the outer portion. By means of four or five 2-in. holes just below the surface of the outer portion the clear solution flows into *B*.

When this circulation has proceeded long enough the holes are plugged with wooden plugs and the clear overflow is allowed to pass through the zinc box and return to the inner cone free, or nearly free, of gold and silver. After this circulation has been started it will be apparent that at any given time the upper portion of the solution in the outer vat, between the inner and outer cone, is the richer in gold. Therefore, if the pulp be allowed to settle in the vat, the supernatant liquid is much richer than that portion in the settled pulp.

One can, if one likes, replace a strong cyanide solution by a very weak one. I treated some slime in London (from Nundydroog Mine, Mysore, India) by my process, and after seven hours' treatment the unwashed residue assayed 0.07 dwt. fine gold per ton. The original slime assayed 2.5 dwt. fine gold. This slime was slightly pyritic. There is even in slime an insoluble minimum of gold, and it would be an interesting problem for someone to find out in what condition this very finely divided gold is, and to explain why it is not soluble in cyanide solution.

It is quite evident that the capital outlay required for a plant which requires so short a time for treatment (the time for settlement must, of course, be added) is very much less than for the present plans in use on these fields. This plant is both easy and inexpensive to work. If the overflow is not absolutely clear, it will have to be passed through a clarifier of some kind; this method is usual to-day in most slime plants.

A plant has been erected on the above principle and has been working for 14 months on the Crown Mines, giving excellent results, which will be described in the paper which follows, so that it will be evident that my process has now passed the experimental stage, as a proof of which are appended some notes by Mr. Fraser Alexander on the "Treatment of Black Sands."

Appendum on the Treatment of Black Sands.

BY FRASER ALEXANDER.

I have been asked to explain the method of treatment and plant adopted at the Crown Mines and worked by me with considerable success since October, 1908, for the quick treatment with cyanide of our battery by-product commonly called "black sand."

After working the plant described by Mr. Burnett for a considerable period, I decided that the sampling of residues could not be relied on, and I often found amalgam accumulated immediately below the stirring gear in sufficiently large quantities to upset all calculations of actual extraction, and this was my chief objection to the paddle stirring process. Seeing a plan of Mr. Andrew F. Crosse's design for the treatment of concentrates, I decided to try the experiment on a working scale, and used for my purpose an old conical-shaped water purifier, 18 ft. deep, by 4 ft. 3 in. at the top, tapering to 2½ ft., to which I fitted air, cyanide solution, and water connections, as shown in the accompanying sectional diagram. This apparatus, which is simple in construction and costs practically

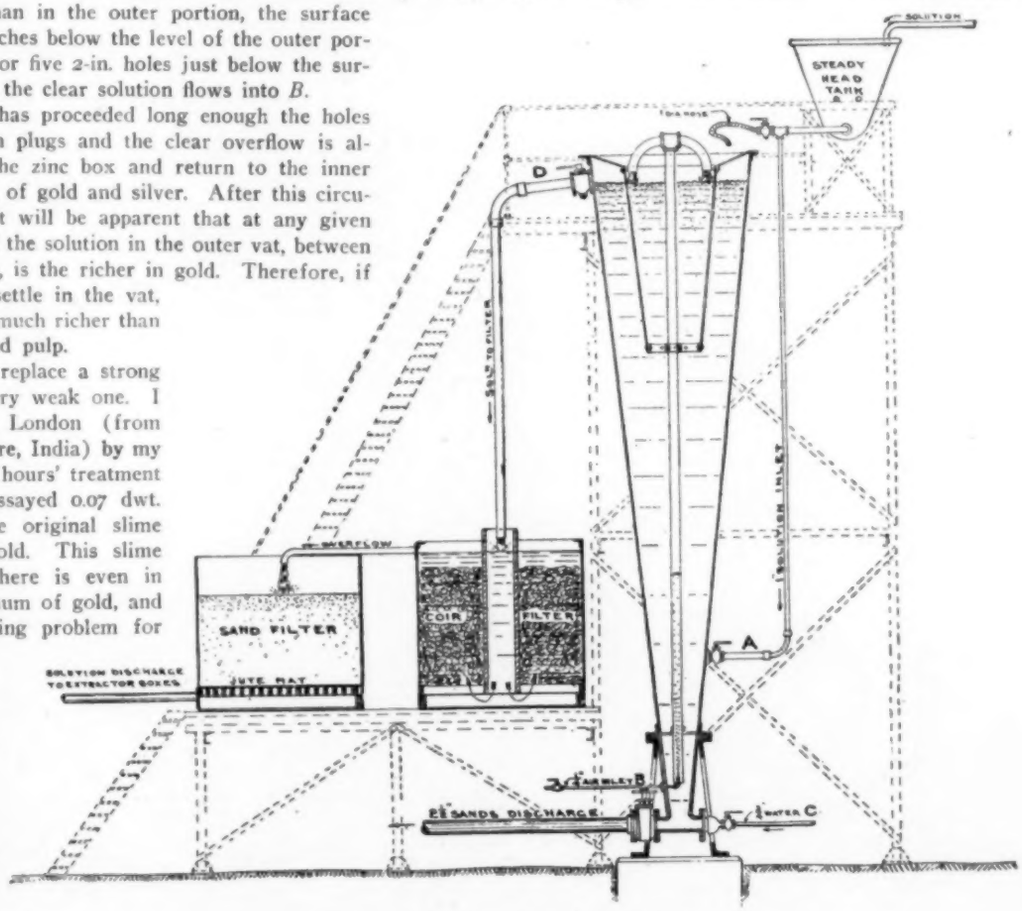


FIG. 2.—BLACK SANDS TREATMENT PLANT.

nothing for maintenance, is extremely reliable and efficient for the treatment of refractory ores with cyanide.

Since installing this plant I have treated 61,340 lb. of black sands, having an average value of 23.0 oz. per ton, from which 683 oz. fine gold = 96.88 per cent and about 150 oz. of mercury were recovered. In many instances I checked the assay values of charges by sampling the solutions, from which I obtained most satisfactory results in measured quantities.

Appended is a fair specimen treatment sheet: Dry weight of charge = 500 lb. charged into the cone with ordinary working cyanide solution to which is added 15 lb. of cyanide and 10 lb. lime. Charged, 2 p. m.; circulated, 8 p. m.; started washing, 9 p. m.; rate of wash = 75 tons per hour, 3 a. m.; KCy = 0.13, CaO per cent = 0.015. Average value solution = 23.35 dwt. After further washing with weak solution (= 0.05 KCy) for six hours, the average value was reduced to 4.3 dwt. 11 a. m., solution KCy = 0.01, CaO = 0.008, Au = 0.30 dwt. Twelve noon to 1 p. m., water wash.

Original value of charge, 25.0 oz. per ton.
Value of residue = 0.51 oz. per ton.
Theoretical extraction = 97.96 per cent.

The process is practically continuous and requires very little attention.

I have no doubt that this method of treating refractory ores with cyanide is capable of considerable extension as a quick method of extracting gold and silver from their ores.

The partial analysis of a sample of treated black sands from the Crown Mines is as follows:

	Per cent.
Silica (SiO_2)	51.94
Iron, calculated as Fe_2O_3	32.62
Sulphur (S)	16.98

Assuming the sulphur to be contained as iron pyrites having a formula of FeS_2, calculation gives the following data:

	Per cent.
Silica (SiO_2)	51.94
Iron disulphide (FeS_2)	31.84
Ferric oxide (Fe_2O_3)	11.39

A qualitative investigation showed the presence of a very small quantity of arsenic, and traces of copper, titanium, cobalt, and nickel. A small amount of lime was also noted, this being a subsequent addition for treatment purposes. A negligible quantity of magnetic iron is present.

* * *

In the brief discussion which followed the above two papers and which is printed in the November issue of the *Journal of the Chemical, Metallurgical and Mining Society* of South Africa, Mr. E. H. Johnson said he had seen the plant in operation at the Robinson mine. The system of agitation is perfect in the central cone and gives a very clear overflow from the outer cone, but he thought that "the point in question is the amount of solution which will be required to complete the washing. In Mr. Alexander's case, I do not think it is a matter of importance, owing to the high value of the original slimes."

The Late Dr. Charles B. Dudley.

It is with great regret that we record the death of Dr. Charles B. Dudley, chief chemist of the Pennsylvania Railroad, on Dec. 21, 1909, at Altoona, Pa. His loss will be keenly felt by all his colleagues in the scientific world. Not only was he very eminent in his chosen field of testing materials, but by his genial disposition, attractive personality, kindness and fairness in dealing with those associated with him, he had endeared himself to his fellow workers and members of the chemical and engineering professions. His death will be especially deplored by members of the International Association for Testing Materials, of which he was the president, his term extending until 1912.

Dr. Dudley was born in Chenango County, New York, on July 14, 1842, and was educated at the local school and academy. The War of the Rebellion having broken out, he enlisted, in 1862, in the 114th New York Volunteers and took part in a number of battles, receiving a severe wound at Winchester in September, 1864. The bullet he received at this time he carried throughout his life and the effects of it may have contributed to some extent to the causes leading up to his death. He left the army in 1865, and went back to his studies, first at Oxford Academy and Institute, in Chenango County, then, from 1867 to 1871, at Yale College. On leaving the latter institution he was compelled to take up newspaper and other editorial work in order to acquire the necessary funds for continuing his education. He then spent two years at the Sheffield Scientific School of Yale University, graduating in 1874 with the degree of Ph.D. The greater part of his time during this stay at Yale University was devoted to the study of chemistry.

On leaving Yale University he acted for one year as the assistant to the professor of physics at the University of Pennsylvania, Philadelphia. He then took up the position of professor of sciences at the Riverview Military Academy, Poughkeepsie, a position which he held for a few weeks only, for, in the autumn of 1875, he received an invitation from the Pennsylvania Railroad to act as their chemist. He accepted the offer, and held this position up to the time of his death.

At the last meeting of the International Association for Testing Materials at Copenhagen, in returning thanks for his nomination as president of the association, Dr. Dudley stated that he had spent his whole life in testing, his thoughts no doubt carrying him back to the day, just 34 years previously, when he commenced the installation of his laboratory at Altoona, in which he was to carry out such useful work, not only for his company, but also for a large number of other concerns and institutions.

His work for the greater part was pioneer work; it covered in the course of a very short time the whole of the large number of materials of different kinds used in the building and the working of a railway, including both the track and the rolling stock: it led to the drawing up of complete series of standard specifications for all the classes of goods required. From the beginning he started minute investigations in the matter of quality and life of steel rails; he carried out these investigations systematically by testing for their physical and their chemical properties rails which had been in service for varying periods of time. His researches in this field, and the conclusions he arrived at, led to his introducing numerous variations in the steel-rail specifications which so far had been accepted.

Dr. Dudley was a pioneer in the investigation of the value of alloys for frictional bearings. He also made an exhaustive study of the most efficient size of bearings for railroad cars, and his experiments led to the adoption by his railroad of wide journals for the heavy cars. Dr. Dudley was elected a member of the Iron and Steel Institute in 1886, and he frequently took part in its discussions. His contributions to the proceedings of scientific associations and to the technical press, quite apart from his specifications for the Pennsylvania Railroad Company, are very numerous, and may be said to cover the whole field of railway construction and working, from the laying of the track to the adequate ventilation of passenger carriages.

Dr. Dudley was at one time president of the American Chemical Society, president of the American Society for Testing Materials and at various times he has occupied a prominent position in other organizations. He was also a member of numerous foreign technical institutions, and, as already stated, he had been four months ago elected president of the International Association for Testing Materials, a position in which by his wide experience and the universal respect in which he was held, he would have greatly forwarded the cause of the association—the unification of methods of testing. Dr. Dudley's contributions in the application of chemistry to the industries will not soon be set aside nor quickly forgotten.

American Institute of Mining Engineers.

The following new members have accepted election to the American Institute of Mining Engineers:

Messrs. Donald J. Browne, Rossland, B. C. Canada; John Marshall Cairns, Glasgow, Scotland; Samuel W. Cohen, Cobalt, Ontario, Canada; Raoul Geer Dufoureq, Arizpe, Sonora, Mexico; James Harold Hance, Salt Lake City, Utah; Frederick Charles Holmes, Santiago de Cuba, Cuba; Clarence T. Hopkins, Jerome, Ariz.; Archabald Stewart Hummel, High Bridge, N. J.; Percy Kenyon, Concepcion del Oro, Zacatecas, Mexico; Warren Lawson Klutty, Thomas, Ala.; S. Arthur Krom, Plainfield, N. J.; Henry M. Lancaster, Wallace, Idaho; Charles N. Lindley, New York City; Robert Livingstone, Edmonton, Alberta, Canada; Eugene McAuline, Chicago, Ill.; James F. McCarthy, Wallace, Idaho;, Atpoll Francis McEwen, Cobalt, Ontario, Canada; Henry A. Morin, Gowganda, Ontario, Canada; Duncan M. Munro, Hostotipaquillo, Jalisco, Mexico; James Negus, Boppy Mountain, New South Wales, Australia; John O. Norbom, Berkeley, Cal.; Horace F. Parsons, Garfield, Utah; John G. Perry, Denver, Col.; Guy Hall Ruggles, Santa Rita, N. M.; Chard Oliver Sanford, Goldroad, Ariz.; Charles H. Schlacks, San Francisco, Cal.; Gustave Schrader, Sutter Creek, Cal.; Tsok Kai Tse, Wickenburg, Ariz.; Rush J. White, Wallace, Idaho. James F. Callbreath, Jr., of Denver, Col., was elected an associate member of the Institute.

Electrical Drive for Rolling Mills.

BY DR. A. S. MCALLISTER.

In considering the driving of rolling mills by means of electric motors one should not lose sight of the fact that the motors are merely elements in a system the whole duty of which is to transmit energy economically from the point where it can be produced most conveniently to the places where it must be utilized to obtain the desired result. To only a very minor extent can electric motors, when substituted for other means for driving rolling mills, affect the sum total of energy actually utilized in the rolling processes or the rate at which this energy is employed. However, the electrical system, of which the motors form one part, when properly arranged for the purpose does affect in a pronounced manner the instantaneous rate at which the energy is produced, and to a limited extent the total amount of energy which must be produced. That is to say, the electrical system can conveniently make use of means for storing energy between the time when it is produced and when utilized, and it is highly efficient in the performance of its duty with reference to the transmission of energy.

The simplest method of adapting electric motors to rolling-mill service is to substitute for each steam engine previously used for the purpose a motor of equivalent maximum horsepower and install a generating equipment suitable for supplying energy to the motors. An electrical installation of this kind would possess certain advantages over the steam-engine equipment, such as efficiency in transmission, cleanliness in operation, and flexibility in control, but viewed from the electrical standpoint it is unnecessarily expensive. Each motor must be capable of exerting the maximum torque demanded of the shaft which it drives, which torque is reached for only a very small part of the cycle of operation, and hence it must be designed for a load which it will be called upon to carry only intermittently for very short periods. The significance of this statement is that each motor must be built of a size many times (from four to eight times) as large as the size of motor that would be required for carrying its average load. Moreover, the generating equipment must be designed for a large maximum load, while it will operate for a major portion of the time at only a fraction of the rated output, and hence will be excessive in first cost and not too highly efficient in operation.

A simple method for decreasing the cost of the generating equipment is to install a storage battery with regulating devices for causing the generators to charge the battery when the load on the system is light, and for allowing the battery to discharge into the system when the load is heavy. By the use of such a battery installation the generators can be designed for the average load on the system, and they will operate continuously at a high efficiency by carrying a load which fluctuates only slightly.

Direct-Current Motors.

When the older steam-engine practice is followed the rolling-mill motors must be of the reversing type and must be capable of accelerating quickly from rest to full speed. This requirement dictates the use of motors of the direct-current type, which are much superior to alternating-current motors for variable-speed and reverse-motion services. Although direct-current motors without special means for suppressing sparking have given excellent results in rolling-mill service, yet there can be no doubt that the severe duty imposed by the fluctuating torque of the rollers can best be performed by direct-current motors when they are provided with interspaced commutating poles. In fact, reversing rolling-mill service furnishes ideal conditions for the application of interpole direct-current motors.

Although the use of a flywheel directly with a reversible motor would be even detrimental to its performance, yet by supplying energy to the reversible motor through a flywheel-motor-generator set considerable advantages are obtained. The motor of the set is so designed that its speed decreases with increase of load; it could be of either the direct-current shunt-wound type or alternating-current induction type. The generator of the set is a direct-current machine, the voltage of which may be varied at will according to the demands of the reversible rolling-mill motor. The flywheel performs a useful service in storing energy from the supply system when the rolling-mill motor is idle and giving off energy to the generator of the set when the demand is greatest. Thus it permits the motor of the set to operate at a load which varies only slightly, although the load on the generator fluctuates enormously. By making the generator of the set a variable-voltage machine much of the energy which would otherwise be wasted in rheostats is saved and hence the efficiency is improved, but the size of the generator is not appreciably decreased thereby. For the purpose of preventing sparking when operating at low voltage with weakened fields and full value of armature current, the generator could be provided with interspaced commutating poles. The use of such interpoles permits the active material of either a generator or a motor to be proportioned for the mean effective load on the the machine rather than for the maximum load, as in the case when interpoles are not used.

An example of a flywheel-motor-generator installation is the equipment of the Illinois Steel Company, where use is made of a 1300-hp motor-generator set connected to a 100-ton flywheel for supplying energy to two 2000-hp reversing rolling-mill motors.

Alternating-Current Synchronous Motors.

In comparison with other motors which may be used for driving rolling mills the direct-current machine possesses the advantage of flexibility in speed control and the ability to receive energy directly from a storage battery. It is disadvantageous in possessing a commutator which requires much attention, and is limited in voltage to a value much below the e.m.f. at which energy can be transmitted economically over any considerable distance. So far as concerns transmission the synchronous alternating-current motor might be arranged to give satisfactory service, but its absolute constancy in speed ratio with the generator eliminates it from consideration where flywheels are to be used for energy storage.

Polyphase Induction Motors.

For the direct driving of non-reversing rolling mills no motor is better adapted than the polyphase induction machine. This motor has no commutator and hence cannot spark. Its torque speed characteristic is identical with that of the direct-current shunt-wound motor, for which it can be directly substituted. In comparison with this motor it is advantageous in being free from commutator troubles and not restricted to low voltages, and disadvantageous in that it cannot receive energy from a storage battery, and in its simplest form is limited to operation at practically a single speed. The disadvantages are of relatively minor importance and have been minimized by the methods outlined below.

When built with a constant secondary resistance—that is, with a squirrel-cage rotor—the polyphase induction motor operates in all respects like a shunt-wound direct-current motor with a constant resistance in its armature circuit. The machine tends at all times to accelerate to a certain definite speed, and under load runs below this speed by an amount depending directly upon the torque which it must exert. Like the shunt-wound motor it can exert its full-load torque at any speed below the normal full-load value, provided the resistance of the rotor circuit is correspondingly increased. Moreover, a combination of two induction motors in series arrangement can be used for obtaining lower speeds just as the armatures of the direct-current motors can be joined in series for half-speed operation. When thus employed the motors are said to be connected in concatenation. An example of the concatenated method of speed control of two induction motors is found at the rolling mill of the Edgar Thomson Steel Company.

So far as the operation of the motor itself is concerned best results are obtained when a polyphase induction machine is

arranged for operation at a practically constant speed without variation in its secondary resistance. Under these conditions the motor could be built with a squirrel-cage rotor, which may well be considered immune from all circuit troubles. Such a motor provided with a flywheel of such a size as to store and give off sufficient energy during each rolling cycle forms an ideally simple machine for the direct driving of a non-reversing rolling mill. Within all operating limits, the lower the resistance of the squirrel cage secondary the smaller may be the flywheel and the more efficient the operation of the motor, but the greater the fluctuations in the load on the supply system. The least load fluctuations are obtained with the heaviest flywheel and with a high value of secondary resistance—not, however, the highest possible value.

In any event the power demanded by the motor from the supply system must fluctuate, because the motor must vary its speed as it accelerates the flywheel in storing energy or allows the flywheel to decrease its speed in giving off energy to the rolls. The mean speed is such that the motor takes from the supply system that average value of power which, multiplied by the time of each cycle, represents the cyclic rolling energy plus the various losses; the fluctuation in speed is such that the flywheel delivers to the rolls the energy to represent all instantaneous excess of demand for power above the value given by the motor and absorbs energy when the motor power is greater than that being used by the rolls.

A flywheel designed to deliver to the rolls the total of the energy represented by all power above the mean value, while decreasing its speed from the mean value to the minimum permissible value, would more than fill the requirements by reason of the inevitable fluctuations in the power of the motor. By sacrificing some of the simplicity of the squirrel-cage rotor, it is possible to reduce materially the fluctuations in the power taken by the induction motor from the supply system. For this purpose the motor is provided with a coil-wound rotor equipped with slip rings so that the resistance in the secondary circuit may be varied as desired. The power taken by the motor could be kept absolutely constant by increasing the secondary resistance in direct proportion to the "slip" of the rotor from its no-load (synchronous) speed; the fluctuations noted above could even be reversed by subjecting the secondary resistance to variation greater than here assumed. The writer is not aware that the constant-load scheme has ever been employed in rolling mills. However, the variable-resistance scheme is used at the Gary, Ind., plant of the Illinois Steel Company, where a storage battery serves to minimize the fluctuations in the load or the generators.

Electrochemical Energy Storage.

Mention has already been made of the fact that in comparison with the alternating-current motor, the direct-current motor possesses an advantage in being capable of utilizing energy directly from a storage battery. At the Gary plant any disadvantage under which the induction motor would labor in this respect has been compensated for by the installation of special rotary converters as connecting links between the alternating-current supply loads and the storage battery. By means of these converters, which are of the split-pole, variable-ratio type, the load on the alternating-current generators is kept as nearly constant as desired in spite of the violent fluctuations in the load on the alternating-current system. One of the most interesting features of the storage battery installations is a variable-voltage generator used for changing the excitation of the converters in accordance with the fluctuation in the load on the alternating-current system. This exciter can be adjusted to maintain the load on the generators at any desired mean value with the fluctuations minimized to any desired degree.

Relative Advantages of Electrochemical and Mechanical Energy Storage.

It will be observed that between the rolls at which the energy is utilized and the generators where it is produced, use is made of two devices for permitting the energy to be generated at a constant rate although utilized with extreme fluctuations in rate, namely, the flywheel and the storage battery. Although performing similar services, and thus assisting each other in producing the desired result, the flywheel and the storage battery possess distinctive characteristics with reference to the transfer of energy which preclude the one being substituted for the other or used exclusively.

The chief advantage of the flywheel resides in its ability to deliver its stored energy at practically any rate demanded. For example, a 50-hp motor-flywheel set could readily deliver energy at the instantaneous rate of 50,000 hp for a limited period, while a storage battery capable of supplying energy at this rate would have to be designed for about 12,500 kw hours; however the battery could deliver this same amount of power for a number of minutes. The significance of this statement is that energy stored in a flywheel is available for instantaneous use, while considerable time is required for extracting energy from a storage battery.

Where a limited amount of energy is to be used for a short time at a very high rate the flywheel is much less expensive and more satisfactory than the storage battery, but where a considerable amount of energy is to be stored for use at a relatively low rate (represented by cyclic intervals of several seconds) the battery is far preferable to the flywheel.

It is to be noted in this connection that the storage battery assists only the generating equipment while the flywheel is of assistance to the whole electrical installation; by its use the motors, transmission circuits, generators, and prime movers may be built for the average rather than the maximum load and operated at the best efficiency. In electrically driven rolling mills the flywheel may well be considered a necessary device. For the best service it should be used on the motor driving the rolls rather than on a generator set supplying energy to the rolling mill motor.

New Uses of Liquid Air and Oxygen.

Some interesting industrial applications of liquid air and of oxygen made from liquid air were noticed in a recent paper read by Mr. George Claude on November 19, 1909, before the Society of Civil Engineers of France.

Commercial plants for the production of liquid air by the Claude process or by the Linde process exist in various European countries (there is also quite a large one in this country using the Linde process, in Buffalo, N. Y.). Their chief product is compressed oxygen, and the principal applications of the oxygen are autogenous welding with the oxy-acetylene flame, cutting of metals with the oxy-oxy-acetylene flame, and the manufacture of artificial precious stones.

But the price of oxygen thus produced is still comparatively high, as Mr. Claude points out, on account of the large expense for compressing and bottling the oxygen gas in cylinders and the shipping expenses. The cost of the oxygen gas would be greatly reduced if it was required in large quantities on the spot. An essential item in the cost is represented by the pressure to which the air under treatment must be compressed. This pressure is given by Claude as 18 atmospheres for apparatus producing 100 cu. m (3530 cu. ft.) of oxygen per hour and is estimated as 10 atmospheres for 1000 cu. m (35,000 cu. ft.).

At present 1 cu. m (35.3 cu. ft.) of oxygen is obtained per hp-hour in apparatus producing 50 cu. m (1765 cu. ft.) per hour. The figure of 1.25 cu. m (44 cu. ft.) of oxygen per hp-hour is guaranteed by the Société de l'Air Liquide for apparatus producing 200 cu. m (7060 cu. ft.) per hour; and the figure of 1.75 cu. m (62 cu. ft.) of oxygen per hp-hour represents the hopes of the manufacturers for apparatus producing 1000 cu. m (35,300 cu. ft.) per hour.

A plant for the yearly production of 50,000,000 cu. m (1,765,000,000 cu. ft.) of pure oxygen requires not more than 20 m by 30 m (65 ft. by 98 ft.) floor space and 15 attendants.

For a plant, to be erected with apparatus producing 200 cu. m (7060 cu. ft.) of oxygen per hour, Mr. Claude's company has guaranteed that the cost of producing 1 cu. m (35.3 cu. ft.) of oxygen, including amortization, will be slightly more than 0.6 cent; that is, figured on the basis of the cost of 0.4 cent per hp-hour (an exceedingly low price which is thought to be justified because blast-furnace gases are used in driving the gas engines for power production at that place).

A very important and interesting experiment on a large scale is soon to be made by a Belgian iron and steel plant, the Société d'Ougrée Marihaye, with respect to the enrichment of the air with oxygen for the blast in one of their blast furnaces and converters. (We comment on this development in our editorial pages.)

At the conclusion of his lecture Mr. Claude showed a number of experiments, like the liquefaction of oxygen in contact with liquid nitrogen; the condensation of atmospheric air on the outside of an iron bottle containing liquid nitrogen; further the fact that coke maintained at the temperature of liquid air absorbs gases with such energy that it is possible to realize rapidly a vacuum of less than one-ten-thousandth of a millimeter. Mr. Claude also subjected a current of illuminating gas fed to a burner, to the action of liquid air; the result was a modification of the flame which assumed the characteristic appearance of the hydrogen flame. This experiment indicates the possibility of a cheap process for making hydrogen by partial liquefaction of water-gas. Other experiments illustrated the ease of recovery of volatile substances in chemical industries by refrigeration, such as ether and alcohol in the manufacture of artificial silk, and the facility of extracting neon and helium from the atmosphere.

* * *

In this connection it is interesting to report a lecture delivered November 18, 1909, before the Polytechnic Association of Berlin, by Dr. H. ERDMANN on the technical application of liquid oxygen. (*Chemiker Zeitung.*)

Dr. Erdmann first discussed briefly the chemical properties of the liquid gas and also described a modified arrangement for investigation of its purity by means of the aerometer. It is possible to utilize liquid oxygen at the same time for three purposes, namely, to utilize its cooling effect, the pressure, and its chemical energy.

The consumption of liquid oxygen is much greater than is generally supposed, although we have no accurate statistics regarding it. Three methods of manufacture are in use. By the Brin method barium oxide (BaO) is heated in a current of atmospheric air to form barium peroxide (BaO_2). The air current is then stopped, and the barium peroxide reheated in a partial vacuum, whereby oxygen is given off. By the second, the electrolytic method, the gas is obtained from water, but this is economical only when there is use at the same time for the hydrogen generated simultaneously with the oxygen in equivalent proportion. Electrolytic cells for this purpose have been devised by Schuckert, Garuti, Schmidt and others. The third method, based on the fractional distillation of liquid air, is now very largely employed in Europe. For operation on a large scale the cascade principle, which was first used by Pictet in 1877, is used to advantage. The lecturer mentioned briefly the processes of Cailletet, Kamerlingh-Onnes, Claude, Hildebrand, and Linde.

Altogether there is annually produced in Germany 8000 cu. m. (282,500 cu. ft.) of oxygen (meaning evidently oxygen gas at atmospheric pressure) by the Brin method, 342,000 cu. m. (12,000,000 cu. ft.) by the electrolytic method, and 2,200,000 cu. m (77,700,000 cu. ft.) by the fractional distillation of liquid air. The average cost for 1 kg of fluid oxygen amounts to about 10 pfennigs.

The oldest use found for oxygen is in explosives, oxygen cartridges not being dangerous. In recent years oxygen has found use in the production of light. In this connection was mentioned the Nürnberg light, which it has been found consumes very little illuminating gas and produces less heat than the ordinary gas lamp. It is also more hygienic since the oxygen is supplied to the flame and is not, therefore, taken from the air, thus contaminating the latter. In metallurgy oxygen finds many uses; for instance, in the oxy-hydrogen and oxy-acetylene flame for autogenous welding and cutting of metals. Oxygen is also used in the production of fused quartz (silica) vessels. Oxygen used in medicine must have the highest purity, this accounts for the higher price. According to Michaelis, oxygen, which is 96-97 per cent pure, costs 6 marks ($1.50) per cubic meter, while 99 per cent oxygen costs 10 marks ($2.50).

Platinum Thermometry at High Temperatures.

The Bureau of Standards has already produced quite a number of excellent researches on pyrometry, which are not only of a high scientific standard, but of great practical importance. Recently a long investigation carried out by Dr. C. W. WAIDNER and Dr. G. K. BURGESS, at the Bureau of Standards, on platinum resistance thermometers at high temperatures has been concluded. The general conclusions are as follows:

First with respect to temperature scales. Temperatures defined by the resistance thermometer of pure platinum calibrated by Callendar's formulæ at 0°, 100° and 444.7° (the boiling point of sulphur), agree with the temperatures on the generally accepted gas scale in the range 0° C. to 1100° C. to within the degree of reproducibility of the latter.

Thermometers made of impure platinum, and calibrated in the same way, do not define the same temperature scale as that of pure platinum, the divergence increasing with the impurity of the metal.

If thermometers of impure platinum are calibrated at a fourth temperature, such as the silver freezing point, and the difference coefficient of the Callendar formula is written $\delta = a + bt$, then the scale so defined by these thermometers is brought into very close agreement with that of the thermometers of pure platinum.

The Dickson formula $(R + a)^2 = p(t + b)$ is not applicable to either platinum or palladium thermometers at high temperatures.

The palladium thermometer, calibrated by the Callendar method, gives temperatures agreeing to 1° with the scale of the platinum thermometer up to 600°. It requires a fourth degree equation to express its resistance-temperature relation from 0° to 1100°.

The following table of freezing points represents the scale of the resistance thermometer of pure platinum as determined from the investigation, using only the purest metals:

	Metal									
	Sn.	Cd.	Pb.	Zn.	Sb.	Al.	Ag_2Cu_2.	Ag.	Cu.	$Cu\text{-}Cu_2O$.
Freezing point	231.92°	321.01	327.43	419.37	630.71	658.0	779.20	960.9	1083.0	1063.2
Average deviation for purest metal	.02	.02	.10	.02	.30	.5	.25	.20	.5	.3
Reproducibility factor	.06	.26	.10	.06	2.3	1.2	...	...	1.0	...

The average deviation of a single observation is a measure of the precision attained when two or more thermometers were used in a single metal sample. The reproducibility factor is the average deviation of the metals, designated as c.p., or better, from their mean F.P.

Thermocouples of Pt, 90Pt — 10Rh and Pt, 90Pt — 10Ir, calibrated at three temperatures in terms of the formula $E = a + bt + ct^2$, define a temperature scale in the interval 200° to 1100°, which is in agreement with the platinum-resistance scale at intermediate temperatures to within 0.3°.

As to the behavior of platinum thermometers the authors

conclude that when used at high temperatures the constants of platinum thermometers undergo gradual changes, which necessitate frequent recalibration in work of high precision. The use of thermocouples for work above the F.P. of silver is, therefore, much less laborious.

These changes in thermometric constants are greatly reduced, but not completely eliminated, by annealing the thermometers for at least several hours at a temperature higher than that at which they are subsequently to be used.

For thermometers of pure platinum, the changes in their constants after the thermometers have been annealed, are very much less than for those of impure platinum.

These changes are least for pure platinum wires of large diameter and suspended free from strains.

For impure platinum wire the effect of high temperatures is such as if the wire became purer, possibly because of the evaporation of impurities, for example, iridium. If the platinum is pure, the slight changes indicate a contamination of the wire and the effect of strains. The total change observed is a resultant of the effects of strains of annealing and of contamination and purification.

Calibration Temperatures.

As to calibration temperatures the authors state that the freezing points of the pure metals are the most satisfactory calibration temperatures, being superior to boiling points in constancy, ease of manipulation, and reproducibility. Unless a very slow rate of heating is used, melting points are less satisfactorily fixed and apparently slightly higher than freezing points.

The temperature of the separation of the silver-copper eutectic is an entirely satisfactory fixed point at 779.2°, when the alloy is of the eutectic composition, or about 72Ag — 28 Cu. The eutectic point of copper-cuprous oxide is also a satisfactory calibration temperature at 1063.2°, when proper experimental precautions are taken to maintain the eutectic composition.

Boiling Point of Sulphur.

The authors also made an extended investigation of the boiling point of sulphur. They find the temperature defined by the vapor of sulphur boiling at known pressure and under carefully specified conditions is a most satisfactory fixed point, reproducible to a few hundredths of a degree. These conditions are, briefly:

(a) Sulphur to be boiled in a glass tube 4 cm to 5 cm diameter and of sufficient length to insure ample depth of immersion in the vapor (tube about 40 cm satisfactory).

(b) Sufficient depth of liquid sulphur to avoid superheating.

A criterion for the above conditions is absence of change in the observed resistance when the thermometer with its attached radiation shields is moved some cm up and down the tube.

(c) Surrounding coil of thermometer with a suitable radiation shield to avoid the cooling effects of the condensed sulphur running down the stem of the thermometer and of radiation to the cooler parts of the apparatus.

Both gas and electrically heated S.B.P. tubes were used; the former gave a temperature 0.03° or 0.04° higher than the latter.

The determination of the S.B.P. by different observers is discussed at length. The determinations of these observers are in satisfactory agreement, the values found ranging, with one exception, from 444.5° to 444.7°. The bearing of some recent work with the gas thermometer on the value of the S.B.P. is considered, which shows that the above value may be too high. The evidence, however, is not sufficient as yet to warrant any change in the generally accepted and widely used value of the S.B.P.

For details of this interesting investigation the reader is referred to the very long and full report of Messrs. Waidner and Burgess in No. 2 of Vol. VI (1909) of the *Bulletin* of the Bureau of Standards.

Natural Gas Production.

According to a chapter of "Mineral Resources, 1908," by Mr. B. Hill, just issued by the Geological Survey, the approximate value of the natural gas produced from wells and consumed in the United States in 1908 was $54,640,374, being greater than that of any previous year. There was a slight decline in 1908 in the Eastern States, as compared with 1907, but this loss was more than made up by substantial gains in the States of the Middle West and South. A further examination of the tables for the last three years shows at least three interesting tendencies: An increasing quantity of gas used for domestic purposes, a decreasing quantity consumed for industrial purposes, and an increased price for the gas.

The production of crude petroleum in 1908 is valued at $120,106,749. Taken with the natural gas this made a combined annual valuation of $174,329,148 for the two products. An examination of the table of production covering the period from 1882 to 1908 shows that the output of natural gas rose rapidly from a value of $215,000 in 1892 to $22,629,875 in 1888, fell gradually in the next eight years to $13,002,512 in 1896, a little more than doubled in five years to $27,066,077 in 1901, a little more than doubled again in the next six years to $54,222,399 in 1907, and, in spite of the financial difficulties beginning in 1907, increased slightly in 1908. This remarkable record seems to indicate that the producton of natural gas has become one of the great established industries of the country, an indication borne out by the extension of the gas districts in the Appalachian field, by the development of the mid-Continental and Gulf fields, which has practically only begun, and by the systematic efforts being made to conserve the consumption of this most useful, convenient and luxurious fuel.

The total number of natural-gas wells productive December 31, 1908, was 21,375. During the year there were 1241 wells abandoned and 2894 drilled. This latter number of wells is itemized as 2148 gas and 746 dry.

During 1908 natural gas to the value of $22,003 was imported for consumption. No exports were recorded. The report shows that Pennsylvania not only leads all States in the value of its gas production in 1908, but also in the combined value of its natural gas and petroleum production. The statistics of the natural gas industry, as given in the table of distribution, show that the value of the gas consumed in this State in 1908 was $20,678,161, as compared with $22,917,547 in 1907, a decrease of $2,239,386. This decrease was due to a falling off in consumption, the quantity decreasing from 164,541,179,000 cu. ft. in 1907 to 147,790,097,000 cu. ft. in 1908. The average price per 1000 cu. ft. was 13.99 cents in 1908, as against 13.9 cents in 1907, a slight advance. The greatest decline was in gas utilized for industrial purposes, the quantity and value decreasing from 119,700,431,000 cu. ft., valued at $12,070,625, in 1907, to 105,587,229,000 cu. ft. valued at $10,536,644, in 1908, this decline being partly due to the lessened demand for gas as a result of the general depression in business which so largely affected the manufacturing districts of this State in 1908. In some instances wells owned by manufacturing establishments which were idle were closed all the year. In the domestic consumption of gas in 1908 there was a decline of 2,637,880,000 cu. ft. in quantity and of $705,405 in value as compared with 1907.

The preliminary report of the Canadian Department of Mines places the value of Canada's natural gas production at $1,012,060. In 1907 it was worth $815,032.

Iron and Steel Institute.—The annual general meeting of the British Iron and Steel Institute will be held at the Institution of Civil Engineers, Great George Street, London, S. W., England, on Wednesday and Thursday, May 4 and 5, 1910. The annual dinner will be held, under the presidency of the Duke of Devonshire, in the Grand Hall of the Hotel Cecil on Wednesday, May 4. The autumn meeting will be held at Buxton on Sept. 27, 28 and 29, 1910.

The Magnetic and Electrical Properties of the Iron Copper Alloys.

BY CHARLES F. BURGESS AND JAMES ASTON.

In connection with an extended investigation of iron alloys, carried out at the Chemical Engineering Laboratories of the University of Wisconsin, under a grant of the Carnegie Institution of Washington, a series of tests were made upon the iron-copper group. The results of various physical tests, including hardness, forgeability, and tensile strength, were described at the October, 1909, meeting of the American Electrochemical Society,[1] and were reprinted in the *Electrochemical and Metallurgical Industry* of December, 1909.

This paper has to deal with the magnetic and electrical properties of the same iron-copper series and is, therefore, supplementary to the one mentioned above.

The details of the preparation of the alloys and of the test samples were given in the previous article, and need not be dwelt upon to any extent here. Electrolytic iron formed the basis of the alloys, together with alloying materials of a corresponding degree of purity; therefore, any properties noted in the tests may be considered as due to the effect of the added elements alone.

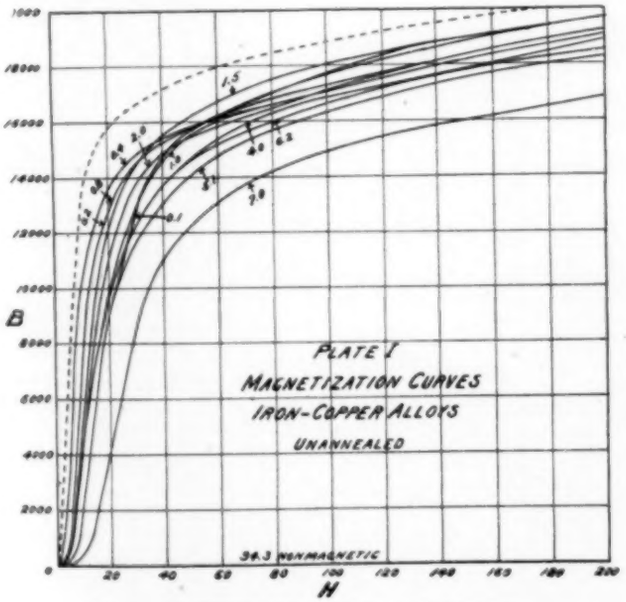


FIG. 1.—MAGNETIZATION CURVES, UNANNEALED.

Tests were made upon 24 binary alloys of iron and copper, and upon 21 alloys with copper-silicon, copper-aluminium, copper-tin and copper-arsenic.

Of the binary alloys the following have been analyzed, and form the basis of the discussion of this series.

	Per Cent Copper.	
Bar.	Added.	Analysis.
147B	0.1	0.089
158A	0.2	0.202
158B	0.4	0.422
158D	0.8	0.804
147H	1.0	1.006
147J	1.5	1.510
158G	2.0	2.005
158I	4.0	3.990
158J	5.0	5.070
158K	6.0	6.160
147U	7.0	7.050
86F	95.0	94.340

The metals mixed in precisely the added proportions. Ingots with all percentages of copper between 7 and 95 per cent were made, but it was impossible to forge this intermediate series until the copper content reached 90 per cent.

[1] Physical Properties of Iron-Copper Alloys, by C. F. Burgess and James Aston. Trans. Am. Elec. Soc. Vol. XVI, 1909.

Magnetic Tests.

The magnetic tests were made upon an Esterline permeameter under four different heat treatments—first, as forged; second, after heating to 675° C. and slowly cooling; third, after heating to 1000° C. and slowly cooling; fourth, after heating to 900° C. and quenching in water. The results are noted in Tables I and II and in Plates I, II, III and IV. All tests are compared to standard bar of electrolytic iron of high quality; the curve for this bar is indicated in the plates by a dotted line. In the unannealed condition the materials fall into two groups,

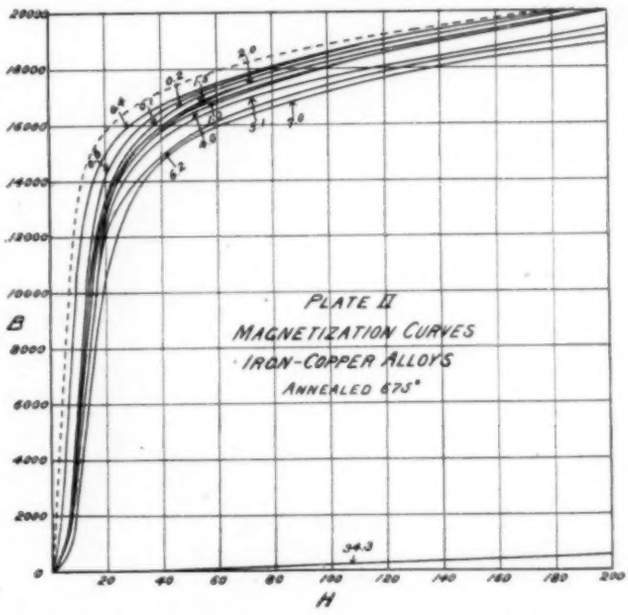


FIG. 2.—MAGNETIZATION CURVES, ANNEALED 675°.

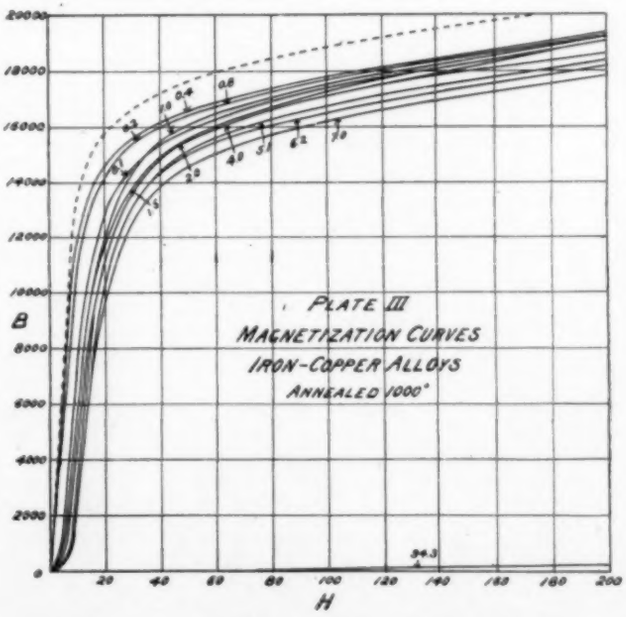


FIG. 3.—MAGNETIZATION CURVES, ANNEALED 1000°.

with those of 1.5 per cent and less irregularly mixed and of the higher magnetic quality; above 2 per cent the permeability falls off rather quickly as the copper content is increased. This is in line with the hardness tests noted in the previous paper. None of the entire series, however, is of a quality worthy of mention; on the other hand, only bars of 4 per cent and up-

wards of copper are conspicuously poor. Bar 86F, with 94.34 per cent of copper, is non-magnetic.

Annealing at 675° has greatly improved the quality of all of the bars, and the curves now fall with considerable regularity into positions indicating a decrease of permeability with increase of copper content. The two best materials are bars 158B with 0.422 per cent Cu, and 158D, with 0.804 per cent copper; the former is but little inferior to the standard electrolytic curve.

Annealing at 1000° has not changed the relative positions of the curves, but has had the effect very generally observed in all of our work of decreasing the densities reached in the upper ranges. For the lower values of H (below 10) there has been an increase of permeability for those alloys of a copper content of less than 1 per cent, but for a percentage of one and upwards there is a deterioration for all values of H.

Quenching at 900° shows practically no change in quality from that of the previous treatment, the annealing at 1000°.

In all conditions subsequent to the unannealed state it has been possible to induce a small magnetic flux in bar 86F, with 94.34 per cent Cu; but the amount is too slight to warrant one in classing this material as other than non-magnetic.

No specific deductions can be drawn from the retentivity values of Table II. The values of coercive force follow a general tendency to diminish with the successive treatments, although in a few minutes the reverse is conspicuously evident. The values are at no time low, except for those alloys of less than 1 per cent copper after heating to the higher temperatures.

The results of the later tests on the 12 binary copper bars which were not analyzed give figures somewhat at variance with the results discussed above, in that three of the bars were of very high magnetic permeability.

Table II.—Coercive Force and Retentivity.

Bar	Per Cent Copper	Coercive Force H (Max.) = 200 Unann.	Ann. 675°	Ann. 1000°	Quench 900°	Retentivity H (Max.) = 200 Unann.	Ann. 675°	Ann. 1000°	Quench 900°
117A	...	5.5	6.2	3.1	2.5	12,300	13,800	10,000	8,000
147B	0.09	13.0	8.7	12.1	4.3	12,700	12,000	10,100	8,400
158A	0.20	7.0	9.3	4.0	3.5	11,100	13,300	8,400	8,400
158B	0.42	7.0	6.0	3.7	3.6	9,900	13,300	8,600	9,300
158D	0.80	9.5	9.5	4.1	4.3	11,500	14,900	8,700	9,100
147H	1.01	14.0	9.5	8.8	5.4	11,100	14,500	10,400	8,700
147J	1.51	12.8	10.5	11.3	7.3	11,100	14,300	12,400	12,500
158G	2.00	10.7	10.0	9.0	8.3	10,200	12,800	10,200	9,900
158 I	3.99	6.0	9.8	9.3	9.7	9,200	13,200	11,100	11,300
158J	5.07	5.7	10.9	11.5	11.2	8,300	13,200	11,500	11,700
158K	6.16	12.5	10.5	11.8	11.8	9,300	11,600	11,800	12,100
147U	7.05	12.5	13.2	12.5	12.6	7,700	12,500	13,100	11,200
86F	94.34	Non.	200+	200+	200+	Non. Mag.	500	300	400

Among the Cu-Si, Cu-Al, Cu-Sn and Cu-As alloys nothing of high quality was indicated, except for four bars where the percentage of added elements is low.

Table I.—Data of Magnetic Tests.

Bar	Per Cent Copper	H = 10 Unann.	Ann. 675°	Ann. 1000°	Quench 900°	H = 20 Unann.	Ann. 675°	Ann. 1000°	Quench 900°	H = 50 Unann.	Ann. 675°	Ann. 1000°	Quench 900°	H = 100 Unann.	Ann. 675°	Ann. 1000°	Quench 900°
117A	C	13,100	10,000	13,350	11,800	15,700	15,950	15,450	14,600	17,600	17,700	17,050	16,950	18,850	18,850	18,200	18,150
147B	0.09	2,900	5,700	7,600	9,200	8,400	13,250	12,800	12,600	15,650	16,800	15,850	16,200	17,600	18,350	17,400	17,600
158A	0.20	7,700	5,700	10,700	10,300	12,800	13,250	14,050	13,650	16,150	16,800	16,350	16,350	18,100	18,350	17,650	17,700
158B	0.42	10,150	10,950	11,700	11,500	13,500	14,950	14,550	14,300	15,800	17,100	16,550	16,650	17,100	18,500	17,700	17,800
158D	0.80	7,700	6,300	10,700	11,000	12,800	14,000	14,150	14,400	15,700	16,950	16,400	16,550	17,100	18,550	17,550	17,800
147H	1.01	2,900	6,300	5,500	9,200	9,600	13,250	11,950	13,450	15,450	16,500	16,000	16,350	17,100	18,050	17,450	17,650
147J	1.51	5,600	4,300	3,500	8,200	12,100	12,650	11,050	13,850	16,150	16,600	15,550	16,200	18,100	18,200	17,250	17,400
158G	2.00	4,500	5,000	5,500	5,600	10,900	12,650	11,600	10,750	15,400	16,450	15,450	15,250	17,050	18,250	17,100	17,200
158I	3.99	4,500	5,700	4,900	4,100	9,600	12,900	11,050	10,750	14,550	16,350	15,450	15,650	16,800	18,050	17,050	17,400
158J	5.07	2,900	4,300	3,000	2,950	8,900	12,350	10,150	10,300	14,000	16,100	15,050	15,300	16,250	17,650	16,700	17,000
158K	6.16	4,500	4,300	2,200	2,400	9,600	12,000	9,600	9,000	14,550	15,550	14,550	14,600	16,550	17,400	16,200	16,350
147U	7.05	400	3,000	2,400	2,950	4,200	10,400	10,150	8,400	12,150	15,450	14,950	14,200	14,900	17,200	16,500	16,150
86F	94.34	0	0	0	0	0	0	0	0	0	200	100	100	0	50	0	0

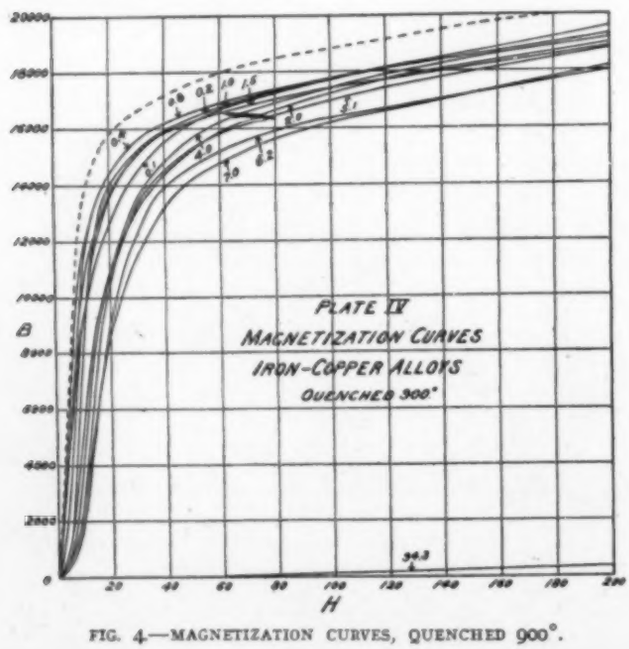


FIG. 4.—MAGNETIZATION CURVES, QUENCHED 900°.

In the light of previous deductions, and because of the absence of accurate analyses, no conclusions will be drawn regarding these high values. They may be the result of high purity of the electrolytic iron and the absence of the intended content of the alloying elements.

Summarizing, it may be said there is no advantage to be gained in adding copper to iron if a good magnetic permeability is wanted. The quality deteriorates almost in proportion to the added copper content. On the other hand, it may be said that there is nothing to be feared from the effect upon the magnetic quality of the small percentages of copper ordinarily found in commercial materials.

In our previous discussions of the physical properties of the iron-copper alloys, stress was laid upon the fact that the alloys with copper content of from 1 to 2 per cent were entirely comparable with the iron-nickel alloys with percentages of nickel from three to four, which is the range ordinarily adopted in

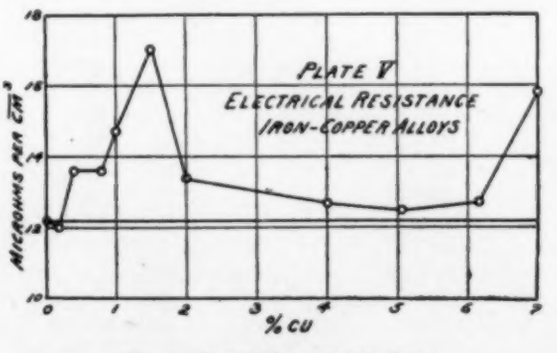


FIG. 5.—ELECTRICAL RESISTANCE.

commercial practice. Direct comparison of the magnetic properties of the above-mentioned ranges is not possible, since we do not have the necessary data for the nickel series. However, it is worthy of mention that the magnetic data of the iron-copper alloys of the above-noted percentages is very similar to that for iron-nickel alloys of 1.93 and 7.05 per cent nickel, and they may, therefore, be taken as equal in magnetic quality to the nickel steels. Again, inspection of the magnetization curves, particularly after annealing at 675° C., shows permeabilities for the alloys of 1 to 2 per cent copper sufficiently high for commercial purposes, should their use be desired because of the increased tensile strength.

Electrical Conductivity.

Results of measurements of electrical resistance are given in the following table and in Plate V. The data are given in microhms per cubic centimeter; also in terms of the relative resistance compared to the same standard bar of electrolytic iron used in the magnetic tests. The bars had all been quenched at 900° C.:

ELECTRICAL RESISTANCE.

Bar.	Per Cent Cu.	Microhms Per Cu. CM.	Relative Resistance.
147B	0.09	12.2	1.01
158A	0.20	12.0	0.99
158B	0.42	13.6	1.12
158D	0.80	13.6	1.12
147H	1.01	14.7	1.22
147J	1.51	17.0	1.41
158G	2.01	13.4	1.11
158I	3.99	12.7	1.05
158J	5.07	12.5	1.03
158K	6.16	12.7	1.05
147U	7.05	15.8	1.31
86F	94.34	3.9	0.24

The conductivity is in no case above that of the standard iron bar, except for bar 86F, with 94.34 per cent Cu. Here the resistance is only one-fourth that of the iron; however, this alloy really belongs at the copper end of the series.

The resistance rises rapidly to a maximum of 17 microhms per cubic centimeter, at a copper content of 1.51 per cent. Between 2 and 6 per cent copper the conductivity is but little inferior to that of the iron, while at 7 per cent the resistance has again risen to 1.31 times that of the standard.

Later measurements upon numerous unanalyzed iron-copper alloys give results so irregularly scattered in relation to those here given that they should be accepted with caution.

CHEMICAL ENGINEERING LABORATORIES,
UNIVERSITY OF WISCONSIN.

The Failure of a Plant for Making Cyanide by the Fixation of Atmospheric Nitrogen.

Records of failures are as interesting and instructive as records of successes, but they remain usually unwritten. An example from the rule is an article by Mr. WILLIAM BETTEL in the *South African Mining Journal*, August 7, 1909, page 640, and reprinted in the *Journal* of the Chemical, Metallurgical and Mining Society of South Africa, November, 1909, page 187. Mr. Bettel writes as follows:

Spasmodic attempts at the manufacture of cyanide, based upon reactions, discovered over 60 years ago, for the fixation of atmospheric nitrogen as an alkaline—or alkaline earthy—cyanide have from time to time been made with more or less success, but I do not think that a description of a plant which was in use in the early nineties, but subsequently closed down owing to its unpayable nature, has hitherto appeared in print.

The works I refer to were in Scotland. A coal-gas works was obtained, suitable additions were made, the process being carried out as follows: Charcoal, selected for its low ash contents and even porosity, was soaked in a saturated solution of potassium carbonate. The charcoal was drained and dried, charged into gas retorts and dry nitrogen (from the air), deprived of oxygen as completely as possible, was passed over the heated charcoal ($+ K_2CO_3$) until the absorption of nitrogen slackened. The charges were then "drawn" out of contact with air, being cooled by the incoming dry nitrogen, and fresh charges introduced. On the average about 25 per cent of the potassium salt was converted into cyanide by the following reaction: $K_2CO_3 + 2\,C_2 + N_2 = 2\,KCN + 3\,CO$. At the same time a certain amount of metallic potassium was formed by the reduction of the carbonate with charcoal: $K_2CO_3 + C_2 + 3\,CO$. The carbon monoxide under certain undefined conditions formed a carbonyl (potassium carbonyl) $K_4(CO)_4$, which has explosive properties.

The crude cyanide so produced was subjected to systematic lixiviation and the saturated solution of $K_2CO_3 + KCN$ decomposed by the CO_2 present in gases from a slow-combustion furnace fed with gas-coke. The operation consisted in passing the gases containing nitrogen and carbon dioxide (with some impurities), through a tower containing coke over which the stream of cyanide solution trickled. The decomposition was as follows: $2\,KCN + 2\,H_2O + 2\,CO_2 = 2\,HCN + 2\,KHCO_3$.

The exhausted liquor, after suitable concentration, was reused for saturating the leached and dried charcoal, with suitable additions of fresh material. The saturated charcoal was then dried as before and went through the above-mentioned cycle of operations.

The hydrocyanic acid gas swept out of the "scrubber" by the nitrogen was absorbed by a cold-water spray in another tower, also filled with coke, the gas being dissolved in the water as hydrocyanic acid. This liquid was collected in stills (actually large steam boilers) and heated with steam coils. The HCN, with some water vapor, passed through a coil cooled to 25° C. to 28° C., which allowed the water to condense and return to the still, while the HCN passed forward. This gas was then condensed in another coil, kept as cold as possible, the liquefied HCN dropped into caustic soda, the compound NaCN, H_2O being formed. The crystals were "fished out" and "centriffed." The trace of caustic soda adhering to the cyanide became converted into sodium carbonate, and the crystals were sold as 80 per cent (equivalent of KCy) strength. By long-continued drying the combined water could be removed to a considerable extent, the "cyanide" content being similarly increased.

When the works were started it was expected that the total cost of manufacturing cyanide (based on 98/100 KCy) would be about 3 d. (6 cents) per pound, but the actual cost was about 1 s. (25 cents) per pound. Among the causes which contributed to this unexpected increase of cost were the following:

(1) Loss of carbonate of potassium by formation of silicate of potassium from ashes in wood and impurites in coke.

(2) Loss of carbonate of potassium by formation of sulphide, sulphate and sulphite of potassium from sulphur compounds in furnace gases and from coke.

(3) Waste of charcoal from oxidation due to porosity of retorts.

(4) Excessive fuel consumption (over that calculated as necessary) for power and heating.

(5) Excessive wear and tear through damages to plant from explosions, etc.

I have in my possession some of the sodium cyanide made by this method, but it has lost most of its water of crystallization. Modern methods in vogue in Europe and America for the manufacture of cyanide of sodium and the mixed (98/100 per cent) cyanides of potassium and sodium are now brought to such a state of perfection that it seems useless to try and make cyanide here by the fixation of atmospheric nitrogen. Recent experiments have convinced me that—in this country at least—such processes are foredoomed to failure from a financial standpoint.

Gold Refining.

The Wohlwill process of gold refining with the recovery of platinum has been the subject of quite a number of articles in this journal. (See especially the article by D. K. Tuttle, Vol. I, page 157, and the articles by the inventor himself, Dr. Emil Wohlwill, in our vol. II, pages 221 and 261, and vol. VI, page 450.) A recent patent of the Norddeutsche Affinerie A. G., with which Dr. Wohlwill is connected (German patent 207,555, Sept. 22, 1908), is exceedingly interesting since it refers to a simple modification which appears to broaden greatly the scope and applicability of the Wohlwill process.

If gold, rich in silver, is refined in a solution of gold chloride containing pure hydrochloric acid or other chlorides, it becomes necessary to remove mechanically from time to time the layer of silver chloride which forms on the anode; in practice it has been found that this is necessary whenever the silver content in the anode is more than 6 per cent. If the layer of silver chloride is not removed from the anode, chlorine is set free and this will take place at an earlier stage of the process, the higher the current density used and the higher the silver content of the anode.

It then becomes necessary to reduce the current density, but this increases considerably the expense due to the smaller output and the increased capital charges per unit weight of output.

A novel arrangement by which these difficulties are overcome is the use of a pulsating current instead of a constant direct current. This is best obtained by connecting a direct-current dynamo in series with an alternating-current dynamo. As long as the voltage of the latter is lower than that of the former, the current obtained by the superposition of the two currents will always have the same direction, but will change periodically from a minimum to a maximum. While such a current produces some good effect in electrolytic gold refining, it is preferable for practical purposes to use an alternator with a higher (maximum) voltage than the direct-current dynamo in series

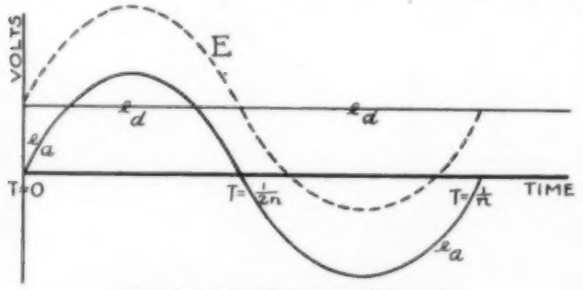


DIAGRAM OF PULSATING CURRENT.

with it. In this case we get a current which has not always the same direction, but is really an alternating current symmetrical with respect to the voltage curve of the direct-current dynamo. The adjoining diagram illustrates the voltage curves. The straight line e_d is the curve of the direct-current dynamo voltage; the curve e_a is the curve of the alternating-current dynamo. The dotted curve E is the resulting voltage obtained by the superposition of the alternating current upon the direct current. It is symmetrical with respect to the straight line e_d.

The electrolytic effect is, according to Faraday's law, equal to the effect of the direct current alone. In other words, the total gold deposited on the cathode can be found from Faraday's law, on the supposition that only the direct current is passing.

The effect of the alternator in series with the direct-current dynamo manifests itself in various ways. The voltage at the terminals of the refining cell measured with a direct-current voltmeter is less than if an absolutely constant current is used. Further, the anodic reaction is essentially influenced by the alternating current. It is possible to increase considerably the anodic current density without causing the development of chlorine gas and without scratching off the layer of silver chloride.

A limit is set to the increase of anodic current density in so far as a relatively weak development of oxygen gas sets in when by increasing the current density the voltage reaches that amount for which chlorine would be set free with a purely direct current. The evolution of oxygen is first so small that the resulting decrease of ampere-hour efficiency is comparatively unimportant. It has even a certain advantage, since it facilitates the dropping off of the silver chloride layer. With increasing current density the evolution of gas becomes stronger. The limit of the current density above which one should not go without decreasing unduly the ampere-hour efficiency, depends on the content of silver in the anodes and on the value of the alternating current strength.

The permissible limit of the direct-current density (amperes per square inch of anode) is the higher, the less the content of silver and the higher the ratio of alternating-current strength to direct-current strength. As soon as a strong gas development takes place at the anodes (more than a few small bubbles) it becomes necessary to decrease the direct current density while the alternating current is not changed, or to increase the alternating current while the direct current remains unchanged.

As an example it is mentioned that if raw gold containing about 10 per cent of silver is treated according to the original Wohlwill process, an anodic current density of not more than 750 amp per square meter must be used, and in this case it is necessary to scratch off the silver chloride from the anode every 45 minutes. When using an alternating current, the strength of which is about 1.1 times that of the direct current, it is possible to maintain an anodic direct-current density of 1250 amp per square meter without any necessity of scraping off the silver chloride.

The method also enables one to treat by the electrolytic refining process alloys much richer in silver than is possible with direct current alone. For instance, gold containing 20 per cent of silver can be refined if the ratio of the alternating current to the direct current is 1.7 to 1 and it is possible to use in this case an anodic direct-current density of 1200 amp per square meter. With lower direct-current densities the process is applicable also for gold still richer in silver, and appears to cover now all cases which occur in practice.

The use of a pulsating current and the resulting possibility of employing high-current densities involves another important advantage. In the original Wohlwill process employing direct current alone, about 10 per cent of the gold of the anodes passes as a finely subdivided dust into the slime and must be recovered by chemical means. If, however, a pulsating current is used, gold passes into the slime only at the beginning of the process as long as the anode is not completely covered with silver chloride. Later on practically no gold whatever passes into the slime.

The slimes, therefore, consist essentially of silver chloride and its spongy structure causes it to drop off by itself. Since at the beginning of electrolysis some little gold always passes into the slime and mechanical losses from the anode cannot be entirely avoided, especially near the end of the refining process, the slime will always finally contain some gold, but generally not more than 1 per cent of the gold content of the anodes. The saving of interest due to this considerable reduction of the gold remaining in the slimes represents a very essential advantage.

On account of the small amount of gold lost from the anode into the slime it is preferable to use a pulsating current instead of a direct current, even in such cases in which gold poor in silver is to be refined.

Whenever an especially high current density of more than 1000 amp per square meter is not of importance, the process has the advantage that the amount of pure hydrochloric acid or of chlorides added to the cell may be much smaller than with

direct current alone. With gold which contains little silver, electrolysis with a current density of 1000 amp per square meter with a purely direct current requires the addition of about 3 per cent hydrochloric acid and the electrolyte must be heated to a temperature of 60° C. or 70° C. The superposition of alternating current upon the direct current permits the use of only one-fourth of the amount of hydrochloric acid (which gives a solution containing about 1 liter of hydrochloric acid, 1.19 s.g., for 60 liters solution—that is, about 7 or 8 grams of hydrochloric acid per liter). On the other hand, if a solution containing 3 per cent HCl or more is used and if the current density is not above 800 amp or 1000 amp per square meter, it is no longer necessary to raise the temperature of the electrolyte to 60° C. or 70° C.

When carrying out the process with a purely direct current the heating of the electrolyte is absolutely necessary, since otherwise the gold is precipitated in form of a dark brown or black powder. This is true even if a current density of less than 500 amp per square meter is used, which seems absolutely impractical in view of the increase of interest charges. So much about the effect on the anodic reaction.

The application of a pulsating current, however, permits also an increase of the cathodic current density in a hot solution; or if the cathodic current density is below 1000 amp per square meter it is possible to obtain perfectly dense coherent deposits even from a cold solution.

The process is carried out in practice as follows: A direct-current and an alternating-current dynamo are connected in series and the voltage of the direct-current dynamo is regulated so that a direct-current ammeter (which does not indicate alternating current) indicates the desired direct-current strength in amperes. If this direct-curent strength is i_d amp and if it is intended to use an alternating current with an effective* value of i_a amp, the effective value of the pulsating current obtained by the superposition of the direct current upon the alternating current is $I = \sqrt{i_d^2 + i_a^2}$. This is the total effective current I as measured by a hot-wire ammeter (the action of which depends on the Joulean heat).

A hot-wire ammeter is, therefore, used in series with the direct-current ammeter and the voltage of the alternating-current machine is now regulated until the hot-wire ammeter shows that the alternating current has reached the correct value. If, for instance, it is intended that the "effective" value of the alternating current should equal the direct current, both being equal to 200 amp, the hot-wire instrument must indicate $\sqrt{80{,}000} = 283$ amp.

The total voltage which determines the power consumption is also measured by a hot-wire instrument. Its value depends on the strength of the total current. If, for instance, raw gold is refined which contains about 10 per cent silver, it is recommended to use a direct-current density of about 1250 amp per square meter and an "effective" alternating-current density of the same value.† the total current density, as found with the hot-wire instrument, is $\sqrt{1250^2 + 1250^2} = 1767$ amp per square meter.

In this case the direct-current voltage at the terminals of the cell, measured by a direct-current instrument, would be about 1 volt and the total voltage about 1.4 volts. This gives an alternating-current voltage of 0.9 volt.

In the design of the dynamos it is best to figure on 1.3 volts as the maximum direct-current voltage, and on 1 volt as the maximum alternating-current voltage per cell. Since both dynamos are connected in series their armatures must be dimensioned so that they can stand the heating effect of the maximum total combined current. Within the usual limits of frequency (that is, for frequencies below 50 periods per second) the value of the frequency has practically no effect on the results obtained with the alternating current.

The most suitable value of the current density and voltage depends, of course, on the composition of the gold or gold alloy. If the gold contains less silver than 10 per cent, it is possible to increase the direct-current density somewhat and to decrease the ratio of alternating current to direct current slightly. If the gold contains much more silver, either the direct-current density should be diminished or the alternating-current density increased.

Otherwise, the process is the same as formerly carried out. In general, gold chloride solutions are used containing at least 3 per cent of hydrochloric acid and heated to 60° C. or 70° C. If, however, time is not of great importance, so that a direct-current density between 500 amp and 1000 amp per square meter can be employed, it is possible to use a gold chloride solution containing only 0.7 per cent to 0.8 per cent of hydrochloric acid and heated to 60° C. to 70° C., or it is not necessary to heat the solution at all if 3 per cent of hydrochloric acid is added.

Instead of hydrochloric acid, or part of it, chlorides which form double salts with gold chloride, for instance, sodium chloride, can be used. As previously described, thin rolled gold sheets are used as cathodes and gold is supplied to the electrolyte periodically in form of gold chloride to make up for the loss of gold from it. If gold rich in lead is refined, sulphuric acid is added to the electrolyte in quantities equivalent to the free hydrochloric acid present.

Rutgers Chemistry Building.—The contract for the new chemistry building of Rutgers College has been awarded and the work is under way. The building will be of brick with terra cotta trim, and will harmonize architecturally with the engineering building which was completed slightly over a year ago. On the first floor will be a large lecture room and three classrooms. On the second floor will be a qualitative and a quantitative laboratory, a laboratory for work in electrochemistry and one for water analyses, professors' private offices and laboratories, and a supply room. In the basement will be the laboratory for the elementary work of the freshman year, a stock room and the necessary heating and ventilating apparatus for the building.

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*The direct current i_d does not change in time, while the alternating current does change periodically. The simplest kind of wave form is a sine wave; we may, therefore, write the instantaneous value of the alternating current $= i \sin(2\pi nt)$ where i is the maximum value of the current, t is the time in seconds and $1/n$ is the period in seconds. It will be seen that the current is zero at the moments $t = 0$, $1/2n$, $1/n$, while it reaches the maximum $+ i$ at the time $t = 1/4n$, and the minimum $- i$ at the time $3/4n$. The arithmetic mean value over a whole period is zero. As this determines the electrolytic action (since according to Faraday's law the deposit is proportional to the product of time and current), the total electrolytic action caused by an alternating current during one full period is zero; in other words, all the electrolytic deposit obtained during the first half of the period (while the current has always the same direction), is being undone during the next half period (while the current has the opposite direction). It is different, however, with the Joulean heat produced by an alternating current because this is proportional to the square of the current; its value during one half period is the same as during the next half period and the two add together. It is, therefore, customary to define the "effective value" of an alternating current (such as indicated by a hot-wire ammeter) as the square root of the mean square of the current. That is, the mean is determined of the squares of the instantaneous values of the current at all moments during a whole period; this gives the "mean square" of the current; by taking the square root, we get the "effective current." It can be easily shown by mathematical calculation, that if i is the maximum value of the current as above the effective value is $i/\sqrt{2}$; this effective value is designated in the text with i_a. With a pulsating current, obtained by the superposition of a direct current i_d over an alternating current $i_a\sqrt{2} \sin(2\pi nt)$, hence of effective value i_a, we can also form the two mean values over a full period. The arithmetic mean, which determines electrolytic action, is simply i_d (as though the alternating current was absent). The "effective" mean value, which is found by a hot-wave ammeter, is $I = \sqrt{i_d^2 + i_a^2}$ as stated above in the text.—Editor.

†If the direct-current density is 1250 amp. per square meter and the effective alternating-current density is also 1250 amp. per square meter, the maximum alternating-current density is $1250\sqrt{2} = 1767$ amp. During that half period of the alternating current, during which the latter has the same direction as the direct current, a certain electrolytic work will be done by the sum of the two currents. During the other half period, some more electrolytic work of the same nature will be done as long as the instantaneous value of the alternating current is below 1250 amps. But during that portion of time, during which the alternating current rises from 1250 amps. to its maximum (1767) and falls again to 1250 amp., the electrolytic action is opposite; what was anode is now cathode and inversely; part of the electrolytic work formerly performed will now be undone. The total electrolytic work performed by the pulsating current (weight of gold refined and deposited) during one full period will be just the same as though we had only a direct current of 1250 amp. But the electric power consumption is, of course, that of both the direct current and the alternating current together.—Editor.

The Use of Carbonaceous Filters in the Smelting of Zinc.*

BY C. O. BANNISTER.

The process described in this paper is the outcome of experiments commenced by Evan H. Hopkins some ten years ago.

These experiments were begun with the object of obtaining zinc free from lead as a product when smelting zinc materials containing lead.

In the first experiments a mixture of zinc oxide, lead oxide and carbon was placed in a cavity in a carbon block fitted with a carbon lid; the carbon block was then introduced into a muffle, and the zinc was distilled over into a receiver. As the result of the experiment, zinc practically free from lead was obtained, and the lead was found in a lump inside the carbon block.

The first idea as to the method of applying this principle on the large scale was to use a modified retort such as that

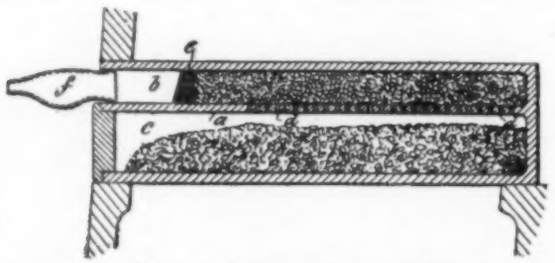


FIG. 1.—FIRST FORM OF RETORT, WITH CARBONACEOUS FILTER.

shown in Fig. 1, and to pass the products of distillation through an incandescent filter of carbon. In the figure given the retort is shown to be divided into two portions by means of a partition, *a*, made of clay, and perforated with small holes, *d*.

The upper chamber, *b*, was filled with fine lumps of charcoal or coke, well pressed together, and kept from falling apart by means of a movable and perforated stopper, *e*. After the ore mixture had been placed in the chamber, *c*, this portion was closed and heated. During the process the zinc distilled through the carbonaceous filter, and was condensed and collected in the receiver, *f*, in the ordinary way.

From the beginning it was evident that in order to make this process a commercial success it would require considerable modification and simplification, and experiments were carried out with a view of making the condenser also take the part of a

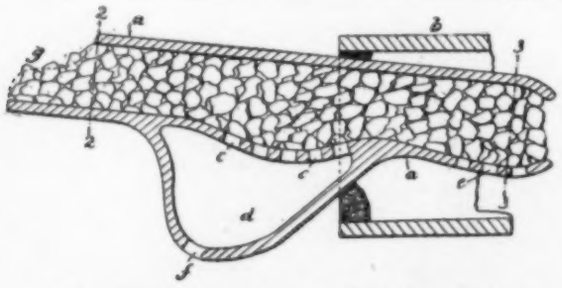


FIG. 2.—MODIFIED CONSTRUCTION OF CONDENSER.

filter. After a large number of experiments the form shown in Fig. 2 was adopted. This consisted of a large condensing chamber divided by means of a perforated partition into a condenser proper and a receiver, *d*.

The upper portion or condenser was filled with small pieces of carbon in the form of charcoal or coke, and the whole was placed sufficiently far into the zinc retorts to insure that the carbon filter should attain a sufficient temperature to prevent choking. This form of condenser was modified slightly from time to time and was used in actual practice, the results obtained being compared with those obtained from retorts fitted with the ordinary condenser. The experiments were made with much care, particular attention being paid to weight, charge, analyses, and like details, and the whole operation was watched for 24 hours without intermission.

During these experiments, which were made in furnaces treating galvanizer's dross, the following points were clearly brought out:

1. The zinc obtained from the Hopkins condensers was invariably purer and freer from lead.

2. No oxide or zinc fumes emanated from the Hopkins condensers.

3. The zinc flame, always observable at the mouth of ordinary condensers, was absent when the Hopkins condensers were used.

4. By the use of the Hopkins condensers a larger proportion of the spelter contained in the charge was obtained as metal.

5. It was established that the hotter the furnace the greater

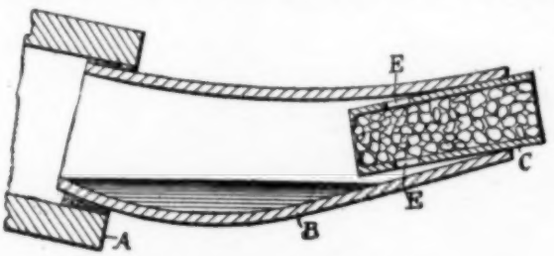


FIG. 3.—CONDENSER CONSTRUCTION.

was the yield of metal by the Hopkins condensers, whereas with the ordinary condensers higher temperature means increased zinc flame, fumes and loss.

It will thus be seen that the above series of trials was most fruitful in indicating the practicability of preventing the zinc fumes which are always a cause of annoyance in the neighborhood of zinc works, and at the same time the prospect of obtaining thereby a greater yield of zinc.

It was, however, considered still possible to simplify the construction of the condenser so as to make it much cheaper. To this end the whole of the central portion of the condenser (Fig. 2) was eliminated, but exactly the same principle was retained in the new arrangement. In this case the condenser, *B*, as ordinarily used in spelter works, or a slightly modified form thereof, may be used, into which is inserted, at the inner end, a carbonaceous filter to keep back the lead, and, at the outer end a tube, *C*, packed with carbon. This combined form is to be used when the aim is to obtain a high quality of zinc as well as the subsequently mentioned advantages, but when it is merely desired to eliminate the objectionable fumes

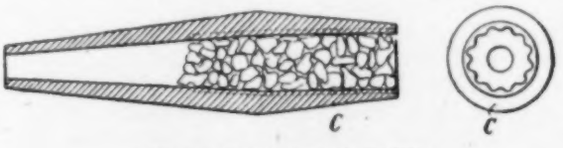


FIG. 4.—CARBONACEOUS FILTER.

and to obtain a higher extraction, the outer tube only need be used as indicated in Fig. 3.

Various forms of fire-clay tubes have been employed to contain the carbonaceous filter; to illustrate one of these Fig. 4 is given, which shows a double conical tube, having one end, namely, that which enters the condenser, made with longitudinal corrugations internally. By reason of these corrugations the choking of the tube is prevented during work, but the escaping gases, etc., come into contact with the hot carbon. The tube at present in use consists of a cylinder about 8 inches long, of 3½ inches external diameter, and 2 inches internal diameter, and has flanges to keep in the coke; it also

*A paper presented before the Institute of Metals at the annual general meeting held in London on January 19, 1910.

has a small hole running through its wall for the insertion of a pricker when found necessary during the process.

It will be seen from the foregoing that the process, beginning with the object of making lead-free spelter only, has been gradually modified and simplified, and in its present form embraces the three following objects:

(a) Manufacture of pure spelter.
(b) Prevention or reduction of zinc fume.
(c) Obtaining of higher yields.

(a) Manufacture of Pure Spelter.

Since Mr. Hopkins first demonstrated the possibility of obtaining pure zinc by passing the vapors from zinc retorts through incandescent carbon, this process has received considerable attention from zinc smelters, and it is now an accepted fact that the operation may be carried out economically and effectively.

To what extent the process will be applied to ordinary zinc smelting is at present unknown, as the demand for zinc of a very high standard of purity is somewhat limited; but there is no doubt that it will be adopted in the treatment of materials containing too much lead for the production of commercial spelter direct, that is, without a subsequent refining operation.

The fact that a carbonaceous filter behaves as a strong reducing agent puts it far in front of filters composed of materials which do not possess this property, for its presence in an incandescent state insures that the whole of the metallic vapors shall be and remain reduced, and at the same time any carbon dioxide passing out with the gases will be reduced to carbon monoxide.

As the amount of reduction that takes place in the filter requires only a little carbon, the consumption of the carbon of the filter is small; but this consumption is advantageous, as it tends to keep open the filter and lessen pressure due to the deposition of lead, etc.

In the actual working, coke has proved more suitable than coal for the filter, and at the same time it is more economical. In fact, experiments have demonstrated that coke is the best material for this purpose, and it should be of a light, porous variety, not dense, and should contain only a small quantity of volatile matter.

As to the results obtained, the following illustrates the purity of the zinc:

From galvanizer's dross the spelter contained 99.86 per cent zinc from the Hopkins filter as compared with 98.75 per cent from an ordinary condenser working on the same charge.

As to whether the process will be used to any extent for the treatment of zinc-lead concentrates, time alone will decide, for details other than the production of pure zinc have here to be taken into account, such as the manner in which the charge attacks the retorts and other parts of the apparatus. For rich zinc concentrates containing smaller quantities of lead, however, there is no doubt that the process is most suitable, as not only can pure zinc be obtained but a considerable quantity of the lead can be recovered on treatment of the filters.

Some comparative tests have been carried out on the treatment of Broken Hill middlings, and not only was a purer zinc obtained from the Hopkins filters, containing 99.6 per cent zinc as compared with 96.5 per cent from ordinary condensers, but the yield of metal averaged over 20 per cent more when such filters were used.

(b) Prevention of Zinc Fume.

In view of the necessity for some cheap, simple and effective method for preventing the formation or reducing the amount of fume during zinc smelting, the Hopkins outer cork is of very great importance, for it is found to be most efficient as a fume preventer.

The presence of this cork or nozzle, packed with carbon, acts in almost a magical manner, keeps back practically all trace of zinc fume, and gives to the gas burning at the ends of the nozzle a flame similar to that obtained during the burning of carbon monoxide gas. The inspection of a zinc furnace fitted partly with ordinary condensers and partly with Hopkins condensers is most surprising and instructive, and the absolute efficiency of the nozzles as now used is at once clearly demonstrated. The presence of the hot carbon at the outside end of the condenser or pipe seems to affect the whole condition of the condenser, for even when put in so loosely that part of the flame escapes between the carbon-containing nozzle and the mouth of the condenser, this flame is also practically free from zinc. From the time the gas in the coal finishes until the last tap, the whole condition of the furnaces supplied with nozzles is improved.

During the periods of tapping the zinc the fumes are very much less, for only two or three condensers are uncovered at a time, and as tapping proceeds, the nozzles as removed are put into the condensers already tapped. The workmen also notice further advantages, for the metal in the condensers fitted with nozzles is hotter than the metal in ordinary condensers, and will more readily melt up "drippings" of spelter; also skulls of metals are never present in the condensers.

The Local Government Board have taken great interest in all methods suggested for the prevention of the escape of zinc fume, and four Government inspectors have examined the Hopkins process in operation in Swansea, and were much impressed by what they saw. The following are extracts from the Annual Report on Alkali, ..., Works, 1908:

Page 90: "In a previous report (42d, page 64) I have mentioned that trials were being given to the Hopkins nozzle, one of the variants of this type of appliance, and with some amount of success. The results of trial have led to simplification in design and construction without, I am informed, any sacrifice of efficiency. It is now believed that not only can spelter of greater purity be obtained, but also in substantially increased yield as compared with other retorts working under the same conditions in the ordinary way without the nozzle. If working for quality, *i. e.*, freedom from lead, the vapors from the retort pass through an additional incandescent chemical filter suitably formed in the furnace end of the condenser. At the outer end of this condenser another appliance aims at reducing any zinc oxide formed in the condenser from access of air to the vapor of zinc. From recent observation of two contiguous benches of thirteen retorts each and comparison of escaping gases near the time of first tapping, *i. e.*, at the period of the greatest liability to evolution of fume, I am convinced of the possibility of success in preventing this in very great measure. It was easy to compare the fume escaping from similar benches not provided with the nozzle, and in the same condition, as to charge and equipment."

Page 180: "Several experimental efforts are at present being made to reduce the impalpable white cloud of oxide of zinc which escapes from the retorts during the smelting operation.

"The 'Hopkins Condenser' is being tried at Swansea with encouraging results. The condenser, which is provided with what may be called a chemical cork, consisting of coke, is adapted to the retort or pot commonly in use.

"By this means the inventor endeavors to prevent the formation of zinc oxide during distillation, thereby obviating the escape of the metal as an oxide seen in the familiar white fumes, inseparably associated with the manufacture of spelter or commercial zinc. At the works referred to, these condensers showed a remarkable diminution in the escape of fumes, and we are informed that there is a substantially increased yield of metal as compared with that obtained by the ordinary process of smelting."

(c) Higher Yields.

The absence of fumes which is noticed when the Hopkins nozzles are in use on zinc retorts should naturally lead to less loss by oxidation and therefore to higher yields of metal.

This has proved to be the case when the process is worked under proper conditions, and the results of continued comparative tests have always shown the Hopkins nozzles to yield more metal. It must be remembered, however, that in the extraction of zinc many factors must be considered which are likely to upset results, such as the breaking of retorts, unequal heating of the furnace, etc. The first comparative tests for yield were carried out on contiguous bays of thirteen retorts, in a two-tiered, gas-fired zinc furnace; further bays of thirteen retorts were added until the whole of one side of the furnace was worked against the whole of the other side.

As the charges in all cases are absolutely similar, only the weight of metal actually obtained need be taken into account.

Table I shows the results of eighteen weeks' continuous work, and it will be noticed that during this run only one week showed a decrease in the amount of spelter yielded by the Hopkins nozzles.

TABLE I.—RESULTS OF FIRST EXTENDED SERIES OF TESTS.

	Ordinary		Hopkins		
Date. Week ending	Average number of pipes used each day.	Average yield per pipe per day. Lb.	Average number of pipes used each day.	Average yield per pipe per day. Lb.	Increase by Hopkins. Per cent.
Oct. 12	143	20.88	13	21.90	4.9
Oct. 19	143	20.43	13	22.90	8.9
Oct. 26	143	20.00	13	21.80	9.0
Nov. 2	130	20.20	11	22.60	12.0
Nov. 9	140	21.26	13	22.94	7.9
Nov. 16	141	22.10	13	23.30	5.4
Nov. 23	133	20.00	18	22.60	13.0
Nov. 30	129	20.20	26	19.00	—6.3
Dec. 7	132	19.20	23	19.70	2.6
Dec. 14	130	19.20	25	20.40	6.2
Dec. 21	129	19.13	25	20.60	7.7
Dec. 28	125	20.90	24	21.16	1.2
Jan. 4	125	20.80	24	22.40	7.7
Jan. 11	129	18.20	26	19.20	5.5
Jan. 18	129	16.10	26	18.20	13.0
Jan. 25	128	15.91	25	17.70	11.2
Feb. 1	127	16.87	25	18.68	10.7
Feb. 8	116	17.54	38	18.85	7.5

Table II shows the results of the first week's work on a recently repaired furnace, one side being worked against the other.

It must be remembered that in the ordinary method of working the zinc furnace the yields vary very considerably from day to day in different furnaces and even in the two sides of one furnace, and therefore it is not to be expected that occasionally for one day, or even in the case of the average for a week, the yield should apparently be less when the condensers are used. On examination of the tables given it will be noticed that there is not only a distinct advantage from the point of view of yield, but also that the percentage variation and the greatest deviation from the mean result are less with the Hopkins nozzles, points which are both in favor of this method.

TABLE II.—DETAILS OF ONE WEEK'S WORK.

	Ordinary					Hopkins					
Date.	No of pipes.	Yield Cwts.	Yield Qrs.	Yield Lb.	Average yield per pipe. lb.	No. of Pipes.	Yield Cwts.	Yield Qrs.	Yield Lb.	Average yield per pipe, lb.	Increase by Hopkins. Per cent.
Oct. 7	75	12	2	25	17.51	75	12	0	21	18.20	3.9
Oct. 8	75	10	1	14	15.49	75	11	2	21	17.45	12.6
Oct. 9	78	11	1	16	16.36	75	12	3	6	19.12	16.9
Oct. 10	78	10	3	29	15.77	78	12	0	17	17.45	10.6
Oct. 11	78	13	0	25	18.98	78	13	2	0	19.25	1.4
Oct. 12	78	11	2	1	16.32	74	13	0	6	19.62	18.7
19.23 75 12	1	10	18.43	—4.1	Oct. 13	78	13	1	16		

It is estimated that the corks or nozzles will be made at a cost of 4s. to 5s. ($1.00 to $1.25) per 100, and that filling for a furnace of 150 retorts will cost 2s. to 2s. 6d. (50 to 62 cents) per day.

Summary.

1. By means of the Hopkins carbonaceous filters and corks or nozzles the following three advantages may be obtained in zinc smelting: (a) Pure spelter; (b) no zinc fume; (c) higher yield.

2. The process may be applied to any already existing retort zinc furnace, no constructive alterations being necessary.

3. Only a slight modification of the condenser is necessary, this consisting in the widening of its mouth.

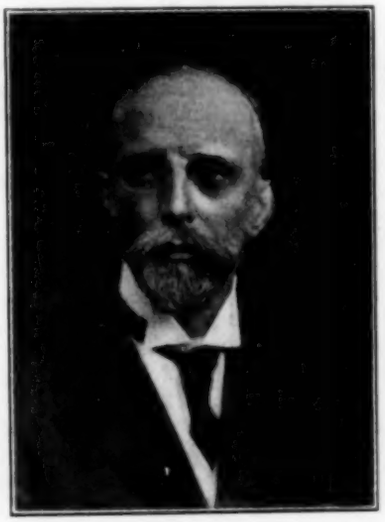
4. The process is absolutely simple to work.

5. The metal is hotter in the condenser, and no skulls of solid zinc are formed.

6. Not only is a higher yield obtained, but also a more steady yield, less fluctuation taking place when the nozzles are in use.

Kirchhoff Luncheon.

Some 130 friends of Mr. Charles Kirchhoff assembled at a luncheon at the Engineers' Club, New York City, on Sunday, Jan. 16, to express their admiration for him as editor and man, on the occasion of his recent retirement from the editorship of *Iron Age* which had extended over 30 years.



CHARLES KIRCHHOFF.

Mr. Philip T. Dodge, president of the Engineers' Club, acted as toastmaster.

Mr. T. C. Martin read letters from many who were unable to be present; among those who had sent expressions of their high esteem for Mr. Kirchhoff were Andrew Carnegie, James Douglas, John Hays Hammond, James H. McGraw, J. Langeloth, John Birkinbine, and W. H. Wiley.

Dr. R. W. Raymond, secretary of the American Institute of Mining Engineers, made one of his delightful characteristic speeches. He referred to the contest for the secretaryship of the Institute in 1885, when both Raymond and Kirchhoff were candidates. This contest became the foundation of a long, firm, and undisturbed friendship.

Mr. George W. Cope, editor of *Iron Age*, spoke eloquently as the representative of the old associates of Mr. Kirchhoff in David Williams Company and presented to him a French bronze by Picault, "La Source du Pactole."

Mr. Kirchhoff's reply, which showed clearly how much he was moved, was as modest and sincere as the man himself.

The final speakers were President Henry S. Drinker, of Lehigh University, and Mr. John Fritz, the veteran iron master, who had come, in spite of his 87 years, from Bethlehem, Pa., to express his regards for his friend of many years.

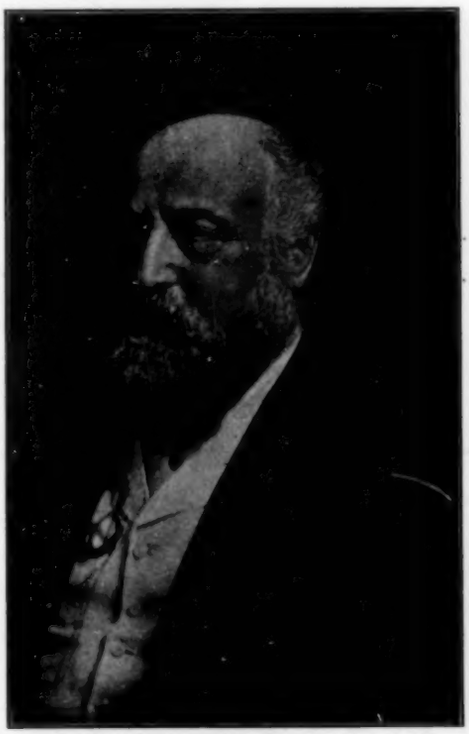
"Auld Lang Syne," played by Mr. Geo. H. Guy, marked the conclusion of the luncheon, which was a modest yet most expressive tribute to one of the greatest, ablest, and most influential editors which the engineering press of any country has ever had.

Mr. Kirchhoff has sailed on a trip to the West Indies.

The Late Dr. Ludwig Mond.

Dr. Ludwig Mond, who died in London before the sun rose on Saturday, December 11, was one of the most successful industrial chemists of his time—a man who owed his success to a rare combination of business ability, capacity for research and energy. The public knew him as one of the founders of the alkali firm of Messrs. Brunner, Mond & Company, as the inventor of the Mond gas and of a nickel process, and as a generous donor to many scientific institutions. We take this account of his life from the London *Engineering*.

Ludwig Mond was born nearly 71 years ago at Cassel, then the capital of the Electorate of Hessen, which since 1866 has formed part of the Prussian kingdom. His father, a merchant, had him trained at the Polytechnic Institute of Cassel, and later at the universities of Marburg and Heidelberg. Recommendations from so distinguished professors as Hermann Kolbe and Robert Bunsen stood young Mond in good stead when, after having held appointments in two German chemical works, he came to England in 1862. He found employment at Widnes in the chemical works of Messrs. Hutchinson and Earle, and there he was able to show that a method patented by him for recovering the sulphur, which had so far been wasted, in the black ash of the Leblanc process was technically applicable; this method was adopted in Newcastle and Glasgow.



DR. LUDWIG MOND.

Returning to the Continent, he joined Ernest Solvay, of Charleroi, near Brussels, the inventor of the ammonia-soda process. Having founded Solvay works at Utrecht, he returned to England in 1867, acquired the Solvay patents for England and started, in 1872, works of his own at Winnington, near Northwich, over the Cheshire salt deposits, with Mr. (now Sir) John Brunner, whose acquaintance he had made in the Hutchinson family, as partner.

It was a risky undertaking to compete in England against the Leblanc process, where it had been elaborated into one of the most perfect cyclic processes known. The raw materials of the Leblanc process are salt, sulphuric acid, coal and lime—all relatively cheap. In the ammonia-soda process the brine is saturated with ammonia—an expensive material—and then with carbonic acid, the crystallizing bicarbonate of soda being afterwards converted, by boiling or by calcination, into ordinary carbonate of soda. The Leblanc process yields hydrochloric acid as a by-product; in the Solvay process the chlorine combines with calcium to form chloride of calcium, and the enormous quantities of this compound remain practically waste heaps up to the present time. A good deal of the success of the new firm was due to the improvements which they effected in the recovery of the ammonia (by means of quicklime). When they started they knew that Dyar and Hemming had tried an ammonia-soda process, likewise in Cheshire in 1838, and had failed, and that the struggle against the giant Leblanc was considered hopeless. After 1875, however, their success was assured. In recent years new and formidable rivals have arisen in the electrolytic alkali processes. To meet that rivalry new efforts were made to utilize the calcium chloride; some of it is now treated with zinc oxide and transformed into zinc chloride, which on electrolysis yields a very pure zinc, and the calcium chloride in itself makes a fair road dressing.

The sight of the enormous waste of gases in his Winnington boilers, it is said, suggested to Dr. Mond the study of the producer-gas problem. He succeeded in burning cheap bituminous slack by the aid of an air-blast and steam and in absorbing the ammonia evolved by dilute sulphuric acid, thus obtaining a fair producer gas and, in addition, ammonium sulphate as a by-product, whose value, unfortunately, decreased, owing to this and other new sources of production. Mond gas is now chiefly made at Dudley Port, in Staffordshire.

The same researches led him to another discovery. The producer gas contains hydrogen, and when, 20 and more years ago, the problem of galvanic gas cells for the direct generation of electricity from coal—not by way of boilers, steam engines and dynamos—excited general attention, Dr. Mond attempted to isolate the hydrogen from the other constituents of the producer gas. For this purpose he conducted the gas over various compounds and metals, and observed that nickel was taken up by the gas; it was the carbon monoxide which formed nickel carbonyl under certain conditions of temperature and pressure, and this carbonyl is again decomposed at 200° C. and deposits a mirror of pure metal. The new compound was first described by Dr. Mond in 1890, and the Mond Nickel Works at Clydach, near Swansea, are now converting part of the nickel ores from the famous Canadian mine at Sudbury, or the matter smelted there, into a very pure nickel.

Years were, of course, required to work out this process, and Dr. Mond had the assistance of many able chemists and engineers in his researches and undertakings. It would be wrong, however, to regard Dr. Mond mainly as the managing director and commercial chief. Dr. Mond was himself a remarkably capable and painstaking research chemist. During the last five years his health caused his friends much anxiety. About a year ago he recovered wonderfully, and he ought to have spared himself. Always busy and hard at work with the general management, however, he took the study of the carbonyls up again, and succeeded in preparing carbonyls of iron, cobalt, molybdenum and ruthenium, which are stable only at very high pressures—450 atmospheres in the last-mentioned case. He announced these discoveries at the International Chemical Congress, which met in London in May and June last. When he fell ill again this autumn grave fears were entertained.

Since 1857 Dr. Mond has been domiciled in England. The year previous he married his cousin, Miss Frieda Loewenthal. His winters he liked to spend in Italy, and his house, the Poplars, in Avenue Road, near Regent's Park, in which he died, is well stocked with masterpieces of the early Italian school. His friendship with the great Italian chemist, Stanislao Cannizzaro, induced him to found a Cannizzaro prize.

Having long supported low-temperature research in the Royal Institution of London, at whose lectures he was a familiar figure, he established the Davy-Faraday Research Laboratory in the house adjoining the Royal Institution in Albemarle Street, and endowed it liberally. The laboratory was opened by the King in 1896. His donations to the Universities of London, Cambridge, Manchester and Liverpool, the Lister Institute of Preventive Medicine, and the association which aims at creating a Chemische Reichsanstalt, a sister institute to the Physikalisch-Technische Reichsanstalt in Char-

lottenburg, were on a grand scale; and it was due to his munificence that the Royal Society, which elected him a Fellow in 1901, was enabled to start its international catalogue of scientific papers. Dr. Mond held honorary degrees from the Universities of Padua, Heidelberg, Manchester and Oxford. One of the honors he valued most highly was his election, in 1898, to the Athenæum Club under the rule which empowers the Council to admit distinguished men of science.

Dr. Mond leaves two sons—Dr. Robert Mond, a Cambridge scientist, and Arthur M. Mond, M. P. for Chester.

* * *

By Dr. Mond's will he leaves $300,000, payable free of legacy duty, on the death of his wife, to the Royal Society of London. The income from this bequest is to be devoted to the assistance of research in the natural sciences along various lines. A like sum for like purposes is also bequeathed to the University of Heidelberg.

In addition to other bequests, Dr. Mond left a fund in the care of six trustees to be chosen by the directors of Brunner, Mond and Company, three trustees to be taken from among the workmen of that firm. The income of the fund is to be used to assist or pension aged or disabled employees of the company. In the event of the dissolution of the company the money will go to the poor of Northwich, where the chief works are located. Another $100,000 is also bequeathed to the city of Cassel, Germany, for charitable purposes. The will then disposes of the collection which Dr. Mond had got together with the advice of Dr. Richter. The collection, which is not large in point of number, was formed slowly, Dr. Mond hardly ever buying more than two or three pictures a year since he made his first acquisition, in 1892.

A schedule annexed to the will gives the names of fifty-six pictures, the list being headed "Pictures for the National Gallery." On the death of Mrs. Mond the trustees of the National Gallery may select at least three-fourths of the works named in this list, or may make up the number, forty-two, from his remaining works of art. These pictures are to be kept together in a room or rooms in the National Gallery under the name of the Mond Collection. He leaves his wife power to bequeath not more than twelve of his pictures to any person she may think fit, but they may not be taken from those selected by the National Gallery.

All the remainder of the pictures are to be given, either singly or in lots, to museums or institutions in Europe or Canada, each one to be marked as the gift of Dr. Mond, but without any restriction as to their being kept together unless at least forty go to one institution. Dr. Mond hoped that the proper authorities will consider the pictures given to the National Gallery as of national interest, and remit all duties that might be levied on the bequest.

The Late Ottokar Hofmann.

We report with sorrow the death of Mr. Ottokar Hofmann, the distinguished metallurgist, which occurred on Dec. 24, 1909, at Kansas City, Mo. Mr. Hofmann's last work was done in Mexico from 1907 to 1908, and during the course of it he encountered hardships which seriously injured his health. Over six months ago he suffered from a complete breakdown, and from then up to the time of his death he was confined to the house.

Mr. Hofmann was born in 1843 at Rusberg, in Austria-Hungary, and educated at the Realschule and Polytechnic Institute in Vienna, and the Bergakademie at Freiberg, graduating from Freiberg in 1866.

In 1867 Mr. Hofmann came to the United States, entering the assay office of Guido Kuestel, in San Francisco, as a partner. This was his first venture.

Mr. Hofmann has largely been identified with leaching processes for the extraction of gold and silver from ores. In 1868 he erected at La Dura, Sonora, Mexico, the first lixiviation works operated in North America, following up this success by the construction of other works at La Trinidad and San Marcial, Sonora, and Trinufo, Lower California. He has served as metallurgist for various amalgamation and chlorination mills in Nevada and California, and since 1880 was engaged in the practice of hydrometallurgy.

In 1895 Mr. Hofmann took charge of the leaching department of the Consolidated Smelting & Refining Company, at Argentine, Kan., and in 1897 he displaced the Hunt and Douglas process then in use by a process which freed copper sulphate solutions in one operation from iron, arsenic, antimony and other impurities. Mr. Hofmann further became consulting chemist for the American Smelting and Refining Company, and consulting metallurgist for the Avino mines of Mexico and chemical director of the United Zinc and Chemical Company, of Kansas. Mr. Hofmann has written a valuable treatise on the hydrometallurgy of silver.

Nitrates in Norway.

The Norwegian industry of manufacturing air nitrates for fertilizer is undergoing rapid extension involving the expenditure of nearly $15,000,000, according to the British consul at Christiania.

Two processes for the manufacture of this product are in use in Norway. The older of the two is the Birkeland-Eyde process, previously described (Vol. VII, page 304), and the newer is that of the Badische Company, also dealt with in these columns. (Vol. VII, page 245.)

Regarding the details of the Norwegian activity we take the following summary from the report of the British consul:

Up till now about $6,000,000 has been expended on the works at Notodden and Svaelgfos and the power stations under construction at Rjukan and Vamma. When all the works are completed, at the end of 1910, $14,600,000 will have been spent. A great point in connection with the development of this industry is that the opportunity has now arisen of opening up several industries in connection with the manufacture of nitrates, such as nitric acid, nitrate of ammonia, nitrate of potash, also sodium nitrate, which last is already being manufactured.

The Nobel syndicate, in conjunction with the Birkeland and Eyde Company, is now concentrating the weak acids, with the assistance of the gas furnaces, to an acid of such percentage as to become an article of transport, and further opportunities have thus been opened for export trade, especially from works with water-power that are situated near the seaboard.

It is of interest to note that no coal is used in the production of saltpeter or other products here referred to. It is stated authoritatively that there is no probability for many years to come that the sale of saltpeter produced by the method practiced at the Notodden and Rjukanfos works will be disturbed by the competition with Chile saltpeter on the question of price.

When the Rjukan Falls works are fully completed, they and the Notodden works combined will represent 240,000-hp, with a production of saltpeter representing an export value of $6,164,000.

At some not very far distant time it is not improbable that the waterways and loughs between Skien and Notodden may be increased to such size as to allow seagoing vessels to load up at Notodden. Plans have already been worked out and are under consideration in connection therewith. At present everything has to be lightered to and from Skien.

The value of the output of nitrates in Norway in 1908 was about $536,000, and the total expenses amounted to $402,000.

The following are the companies that are producing, or will shortly produce, saltpeter from the air:

(1) The Norsk Hydro-Elektrisk Kvaelstof Aktieselskab, Christiana, who are the owners of the Notodden Saltpeter-

fabrikker, the power of which (35,000 hp) is supplied from the Svaelgfos. The capital of the company, which is French, is $7,890,000.

(2) The Vammafos (Vamma Falls) Company, whose saltpeter works are now under construction. This company is a separate company, but half of its shares are said to be owned by the Norsk Hydro-Elektrisk Kvaelstof Aktieselskab; some of the preference shares are in the hands of Norwegians. The amount of the capital cannot be stated.

(3) The Rjukanfos (Rjukan Falls) Company, whose saltpeter works are also in course of erection. The capital of the company, which is one-half French and the other half Scandinavian and German, is $3,376,800. This capital has been furnished by some of the shareholders of the Norsk Hydro-Elektrisk Kvaelstof Aktieselskab and of the Kraft Aktieselskab, but the company is an independent one.

(4) The Matre and Tyin waterfalls are owned by the Norsk Hydro-Elektrisk Kvaelstof Aktieselskab and by the Kraft Aktieselskab, but the companies formed in connection with these falls are two separate companies with separate administrations. Electrotechnical works will probably be erected at both falls.

(5) Christianssands Elektrokemiske Aktieselskab, which is the property of the Badische Anilin und Soda Fabrik, Ludwigshafen, and has a capital of $53,600.

The Chemist's Place in Power Economy.

Industrial progress depends no longer on "*increased* production" only, but on "increased *efficiency* of production." Nowhere more than in the production and transmission of power are there greater opportunities for improvement for the saving of time, and labor, and money. That the chemist ought to take the foremost part in solving the problems of power efficiency is the argument convincingly set forth in a paper read at the recent convention of the American Chemical Society by Mr. ARTHUR D. LITTLE, of Boston.

Mr. Little made a vigorous presentation of the chemist's special qualification for dealing with problems of power, which should no longer be monopolized by the mechanical engineer. It is sometimes forgotten that chemical science deals with energy no less than with matter. In fact, chemistry as a science, began with the recognition of the principles, materials, and products of combustion. But chemists have allowed the mechanical engineer to usurp many things which properly come much more directly within their own province.

The combustion of coal is a typical chemical process. The selection of the most efficient coal and the determination of the conditions necessary for its most efficient combustion are essentially chemical problems. Chemical problems also are those arising in the manufacture of producer and illuminating gas, their utilization in gas engines, the development of power from the waste gases of the blast furnace, the adaptation of conditions to the proper handling and burning of peat, lignite, and waste coal, the thermometric exploration of coal piles to forestall spontaneous combustion, smoke abatement, the control and improvement of fireroom conditions by draft regulation, flue gas analysis, temperature measurements and even the placing of firemen on the bonus basis. Taking power-plant practice and the conditions of coal purchases as they stand, the properly equipped chemist should be able to increase the efficiency of power production from 5 per cent to 30 per cent.

The analysis of boiler compounds as an end in itself presents little to excite enthusiasm, but when such analyses become the means of saving $3,600 a year in the power plants of a single company they take on a new and larger aspect, not only in the mind of the chemist, but in the mind of the chemist's client.

The chemist who attacks the problems of power production will not hesitate to go outside the laboratory and take his property wherever he finds it. He will conduct boiler and engine tests, study the efficiency of grates and stokers, familiarize himself with the marvelous promise of the low-pressure turbine as an agent in efficient power production. While straining every resource of his science to produce steam economically by the combustion of coal, is it common sense for the chemist to stop there in ignorance of the fact that the efficiency of that steam can be increased at once from 25 per cent to 100 per cent by coupling a turbine to the exhaust?

The distribution of power-supplies problems no less directly within the province of the industrial chemist. He may begin with the analysis of lubricating oils. He proves his own inefficiency if he stops there. He must inform himself regarding the market prices of oils used elsewhere for similar service, the adaptability of the oils in question to application to the bearing by soaked waste, sight feeds, or gravity cups. He must be prepared to interpret his analysis in terms of practice and to follow the oil through the plant in order to prescribe conditions which shall keep down waste. There are few plants in which the industrial chemist working along legitimate lines cannot save from 20 per cent to 60 per cent of the entire lubrication account, while the oil analyst has to his credit merely a few figures which his client probably fails to understand.

The efficiency and life of bearing metals varies over an extraordinarily wide range. Some are merely the refuse from type foundries, others are so carefully adapted in their composition to the requirements of particular service as to show an efficiency 15 times or more as great as that of inferior material. Here, again, the mere analysis means little, the practical question is: "Which is the more efficient metal under the conditions imposed by practice?"

Much additional might be said regarding the opportunity before the chemist when any material concerned in power transmission is the subject of his study, whether it be leather, rubber or canvas belting, belt dressings, insulating material, trolley wire, trolley cars or trolley wheels. In every case it is within his power to create a new standard of efficiency.

Notes on Metallurgy and Chemistry in Great Britain.

(From Our Special Correspondent.)

Institution of Mechanical Engineers.

At the meeting on December 17 papers were read on "Mild Steel Tubes in Compression and Under Combined Stress," by Mr. W. Mason, and on "Compound Stress Experiments," by Prof. C. A. M. Smith.

The discussion was opened by Mr. J. J. Guest, who said that he thought the authors had not explained sufficiently fully the aim they had in view. He said so, because, after reading a similar paper himself, he found that many in his audience had been unable to acquire a precise idea of the ground he wished to cover. When a specimen was put in an ordinary testing machine it would break at a certain number of pounds per square inch; and a tension member in a bridge could be strictly compared with the result of such a test. In the case of mild steel in an unstayed boiler there was a hoop-like stress around the boiler, as well as the longitudinal stress, and the material was consequently subjected to tension in the two principal directions at right angles to each other. Experiments in ordinary testing machines did not give any evidence as to the second tension affecting the capacity of the material in respect of the first tension. The experimenters were trying to solve the following questions: (1) Could the effect of tension on the resistance of the material be ascertained? and (2) Would the second stress diminish the material's capacity of resistance? In the case of the crankshaft referred to by Professor Smith the second stress was of an opposite nature to the first; that is, one was a stress of tension and the other a compressive stress, or vice versa.

Experiments which Mr. Guest himself had carried out had satisfied him that the shear stress was the chief factor in the case of ductile mild steel, but the authors had extended their

researches to new ground. He would first criticise Mr. Mason's experiments. He did not think that two of the figures represented a perfectly fair view of matters. Mr. Mason had tested his material in axial tension, and found it gave a certain point, *A*. He had also made experiments corresponding to the boiler plate and had applied equal tension to test pieces both longitudinally and laterally, thus getting another point, *B*, as the yield point for combined axial and hoop tensions. A new tension in a direction at right angles to the first would not lower the capacity of the material to resist the first tension. In dealing with stresses combining tension and compression, Mr. Mason had first subjected the material to compression, and ascertained the yield point. Then he had applied a certain tension in combination with an equal stress of compression, and found that he could not apply much more than half the previous stress. The stress in the material in such cases was purely shear stress, and as a consequence the second stress had a great effect on the resistance of the material to the first stress. Mr. Guest's further remarks on Mr. Mason's paper are not intelligible without the aid of a diagram.

Professor Smith, as well as others, had criticized the use of tubes for these experiments, but while Mr. Guest fully recognized the necessity for using solid test pieces in some cases, he considered that in others tubes would give useful and reliable results. The whole problem of compound stresses in mild steel appeared to have closely approached solution. It was a fortunate circumstance that the problem had been attacked by the authors in totally different directions. He considered that the axis of stress was never coincident with the axis of the specimen, although in his own tests he had endeavored to make them coincide. The ordinary testing machine was merely a weighing machine, not an instrument of precision, and too much should not be expected from it. The chief point raised by Professor Smith was that where tubes were loaded in compression they might fail through secondary flexure. Mr. Mason had also had that kind of trouble, but, of course, when it occurred the tests must be rejected. Professor Smith had stated that engineers seemed to lack confidence in tests in tubes because they knew the probability of flaws existing in cheap tubes, and this naturally made them suspicious even of tests in good tubes.

Mr. J. P. E. C. Stromeyer regretted that Mr. Mason had not given the hoop-tension, which would have completed the curve. With regard to Professor Smith's paper, the author seemed to infer that when a ratio of maximum stress to mean stress did not exceed a certain amount the material would not fail. From this it might appear that the stress could be increased to infinity without failure, if only the ratio were not exceeded. [Professor Smith rose and pointed out that stresses on the third plane had to be taken into consideration, and that the speaker's conclusion was erroneous.] With regard to the use of the sphingometer, he had arrived at the conclusion, as long as 20 years ago, that several instruments should be used to ascertain the elastic limit. He had always used two instruments, and for testing in connection with a Blackfriars' Bridge he used four. One objection to Professor Smith's instrument was that the coiled metal strip was not of the same material as the metal which was being tested, and the difference in the coefficients of expansion would affect the accuracy of the instrument.

The Physical Society.

The fifth annual exhibition of physical apparatus was held at the Imperial College of Science, South Kensington, on December 14. The exhibits fully maintained the standard of excellence of which the experience of previous years warranted the expectation.

The Bausch and Lomb Optical Company had some very efficient microscopes of new model, microtomes, electrical centrifuges and their opaque projection apparatus. The Cambridge Scientific Instrument Company showed new patterns of the Féry radiation pyrometer, in use with a Méker furnace, having decided advantages over last year's types; automatic temperature regulators, a newly designed Duddell thermo-galvanometer, and a very sensitive gas-leakage indicator. On the stand of Cassella & Company were Captain Sankey's metal-bending tester, recording rain gages, a gradient telemeter level, Hepworth's electric artificial horizon, and the Hennah & Rissel automatic safety-course recorder and indicator for ships. Harry W. Cox & Company exhibited large induction coils for radiography and wireless telegraphy, a new type of gas interrupter, and wireless telegraphy sets.

Mr. T. Thorne Baker's instruments for telegraphing photographs, shown in operation by the *Daily Mirror*, attracted considerable attention. Elliott Brothers displayed the Wimperis accelerometer and gradient measurer, for which are claimed accurate and rapid measurements of starting acceleration, retardation, comparative braking efficiency, tractive effort at varying speeds, and slopes and gradients. They also had an effective selection of their well-known electrical instruments. Everett, Edgcumbe & Company's exhibit consisted mainly of electrical measurement instruments and photometers. Gambrell Brothers showed some well-designed instruments, including their new "foolproof" pointer and reflecting galvanometer. Mr. F. Harrison Glew demonstrated his novel "radium collector" for atmospheric electricity, which can be employed to give time records, operate continuous electric chimes and perform other like operations, also an electric recording inclined plane and spark counter, and an actinium emanation lamp. John J. Griffin & Sons exhibited Sand's apparatus for rapid electro-analysis of metals, a gamma-ray electroscope, and a temperature recorder connected to quartz-glass platinum resistance thermometers.

Notable among Mr. James J. Hicks' instruments were a compensated micro-manometer, indifferent to vibration or changes of level, and a meteorograph for attaching to kites to obtain a record of pressure, temperature, humidity and velocity of wind in the upper air. A. Hilger & Company had a capital display of spectroscopic apparatus, and a 56-plate diffraction grating. The Marconi Wireless Telegraph Company had their improved valve receiver in operation. Nalder Brothers & Company showed a Duddell's patent bifilar vibration galvanometer and Mansbridge's variable standard of self-induction; Nalder Brothers & Thompson, a telethermometer, consisting essentially of a moving-coil ohm-meter combined with a Wheatstone bridge, and a lamp-testing wattmeter. Negrette & Zambra showed meteorological instruments. Newton & Company made an attractive feature of gyroscopes, synchronous springs and pendulums, and the Wilberforce spring.

Mr. Robert W. Paul demonstrated the use of the Sumpner reflecting dynamometer and the Paul single-pivot dynamometer. The Reason Manufacturing Company showed Wright's electrolytic meter, two other forms of meters, and a very ingenious battery-driven clock of very simple and apparently efficient mechanism. Messrs. Ross., Ltd., exhibited excellent cameras and microscopes; Siemens Brothers & Company had an extensive assortment of electrical instruments, including a portable current transformer for accurate laboratory work. Snell & Tinsley had on their stand several instruments embodying new developments, among which were Drysdale's alternating-current potentiometer, the sine-flux phase shifter, a phase-shifting transformer, and an improved siphon recorder. The Weston Company made an especial feature of their models 151 and 156 voltmeters and ammeters, for which they claim no inductance error, no discernible working error, no chamber error, deadbeat, and very uniform scale. The mineralogical and metallurgical microscopes shown by Carl Zeiss also deserve mention.

During the afternoon and evening Prof. C. V. Boys, F.R.S., gave two demonstrations with soap bubbles, after which Prof. S. P. Thompson, F.R.S., showed some combinations of mica and selenite crystals.

The Faraday Society.

The proceedings at the annual general meeting on Nov. 30 were very brief. Dr. Sands' paper on the electrolytic determination of lead as peroxide was read by Dr. F. Mollivo Perkin. The speaker, who opened the discussion, said he quite agreed with Dr. Sands as to the necessity for high density of the peroxide, the employment of high temperature, initial elimination of water by alcohol followed by ether, and drying at 200°. Dr. Seuter briefly pointed out some apparent discrepancies. Dr. Perkin replied that the difficulties which had arisen were due to omission of the working with alcohol and ether. He had not arrived at satisfactory results with alkaline solutions. There was very great difficulty in freeing the peroxide from alkali. With the nitric solution the whole of the lead was deposited in about 20 minutes, but with alkaline solutions a much longer time was required. The other papers evoked practically no discussion.

New Uses for Blast-Furnace Slag.

A new process for the utilization of blast-furnace slag has been worked out by W. P. Thompson Company, of Liverpool. Sand and sodium sulphate, with a little lime if required, are put into the furnace with the result that the slag is converted into a glass, which can be cast into blocks or rolled out, with or without wire reinforcement, into sheets for use as slates, slabs, tiles, building and paving blocks. Where the introduction of sand and sulphate into the blast furnace is not permissible, these materials are added and melted with the slag after this has been run into a reverberatory furnace; but this process demands care to ensure thorough mixing, and entails increased charges for fuel. The inventors claim that they can produce roofing slates of any size, shape or color at less than half the cost of Welsh slates, while this translucency is a great advantage. Building blocks of this material have a polished surface which will not permit adherence of sooty matter and thus always retain a bright appearance, and are, moreover, quite waterproof. The Patent Corporation, of Liverpool, is experimenting with slags from various sources.

LONDON, January, 1910.

Synopsis of Metallurgical and Chemical Literature

Iron and Steel.

Cementation by Carbon has been studied by L. GUILLET and CH. GRIFFITH, their results being published in *Revue de Métallurgie*, October last. Their object was to determine if carbon alone would cement iron by contact in a vacuum where the absence of gases was assured. Special precautions were taken to first remove dissolved gases from the iron and from the carbon used. The carbon was tested simply in contact with the iron and mechanically pressed against the iron. Their conclusions are important.

(a) In a vacuum, pure carbon does not cement iron unless mechanical means are provided to press it into contact with the metal. As the pressure is increased, cementation increases.

(b) Carbon *alone* plays but an insignificant part in industrial cementation processes.

(c) Dissolved gases, from iron or carbon, will promote cementation.

Moisture in Cupola Blast is discussed by Engineer A. MESSERSCHMIDT, of Wiesbaden, in *Stahl und Eisen*, Dec. 1. He calculates that since as much as 15 cu. m (525 cu. ft.) of air is blown in per kilogram of coke burned, that this may carry in wet weather as much as 0.2 kg of moisture, whose decomposition absorbs some 10 per cent of the calorific power of the coke. The damage done cannot be repaired by simply using 10 per cent more coke, because the real factor affected is the combustion temperature before the tuyères, and while this is materially lowered by the decomposition of moisture, it is not regained by increasing the coke. It is, therefore, common experience to find the cupola iron running cold in damp, warm weather, and unable to make sharp, thin castings. Messerschmidt cites a case where the cupola blast was taken from an underground conduit 15 m long, which was often partly full of water, thus giving air to the cupola saturated with moisture. Drying of the cupola blast will save melting coke, and give a more uniformly heated and hotter quality of melted iron.

Corrosion of Iron.—In the very interesting yearly report of the Bureau for Testing Materials of the Institute of Technology of Berlin for 1908-9 an account is given of the results obtained in the researches of E. HEYN and O. BAUER. The authors had formerly studied corrosion of iron in a solution of one special salt in water. They have now extended their investigation to the solution of salt mixtures. One special point is emphasized: In their former investigations the pieces of iron were completely suspended below the surface of the liquid. The speed of corrosion depends in this case on the quickness with which fresh oxygen can come by diffusion to the surface of the iron from the surface of the liquid. If, however, the iron samples are only partly suspended within the liquid, the rust which forms along the line of contact between the iron and the air acts as a transmitting medium for the oxygen downward. It acts like an oxygen sponge. The speed of rusting of the iron below the surface of the liquid depends now also on the nature of the rust; if this is porous or spongy it is a better transmitter of oxygen than if it is dense and compact.

Various cases of corrosion of boiler tubes and other apparatus were investigated. The general public usually blames the steel. But the bureau has repeatedly pointed out that in most cases the cause of strong corrosion is not to be found in the material of the steel, but in the method of operation. For instance, the way in which the feed water is supplied to the boiler may have considerable influence. If the water has an opportunity to absorb considerable quantities of oxygen by saturation with air, the oxygen is set free in form of little bubbles when the air is heated during operation. The oxygen bubbles adhere to the iron surface and produce corrosion. The bureau had formerly recommended the use of charcoal filters in the pipes for the feed water, but no results from practice have yet been reported. In five cases of corrosion of boiler tubes which were investigated the fact was established that the fault was not in the steel; in almost all cases the nature of the water was to be blamed, since very pure water (distilled water) was used. The bureau emphasizes strongly that the distilled water attacks iron in presence of oxygen far more strongly than most ordinary kinds of water. In one case the iron had been painted with a protected paint almost over the whole surface, with the exception of one end which had been left unpainted. This showed strong corrosion and it was found that the corrosion had also progressed from this end further below the protective film of paint.

Rail Steel.—In the same report a comparison of the microstructure of various kinds of steel is reported. Electrically refined rail steel was found free from slag enclosures; all other kinds of rail steel investigated were found to contain slag enclosures.

Ductile Electrolytic Iron.—At the last convention of the German Bunsen Society the Langbein-Pfanhauserwerke A. G. of Leipzig exhibited various samples of electrolytic iron made by the method of F. Fischer, from ordinary "commercial iron" with cathodic current densities up to 20 amperes per square decimeter or more (the composition of the electrolyte being not

stated). This electrolytic iron which has properties quite different from Burgess' electrolytic iron, contains not more than 0.05 per cent impurities (Gumlich gives the following analysis: 0.024 C, 0.004 Si, 0.008 Mn, 0.008 P, 0.001 S.) It is soft, the hardness in the Brinell scale is 92 unannealed, 62 annealed (while silver is 91, aluminium 52). Rolling increases the hardness; when a 3-mm plate was rolled out to 1.2-mm thickness, the hardness increased from 90 to 126; further rolling out to 0.6-mm thickness increased the hardness to 175. After annealing, however, the hardness dropped again at once to 60 or 62. This kind of electrolytic iron is easily worked, cut with the knife, rolled cold, and can be forged. It can be hardened in the whole or in parts by absorption of carbon. The magnetic qualities are excellent. Electrolytic iron sheets in thicknesses from 0.1 mm or less to 8 or 10 mm can be easily made by deposition on a metallic cathode. For steel cuts or electrotypes this electrolytic iron is specially suitable, since it is possible to carry out the process directly in such a way that the front of the cut is hardened, while the back is ductile. Seamless tubes, made by this process, were also exhibited (20 mm diameter, 1 mm thickness), also a lead pipe of 20 mm diameter and 0.5 m in length, armored with an adhesive iron coating of 1 mm thickness. (*Zeit. f. Elektrochemie*, Aug. 15, 1909.)

Electrolytic Steel.—A. Müller (*Métallurgie*, 1909, p. 145) has experimented largely on this subject. As anodes he used various soft steels and soft iron; as cathodes, iron, copper, lead, tin plate. The deposited iron detaches most easily from copper or lead. The best electrolyte was found to be a 30 per cent solution of double iron-ammonium sulphate, worked cold. The best cathodic current density was between 50 amp and 80 amp per square meter (5.5 amp to 7 amp per square foot). It is recommended to work under the following conditions: Use anodes as pure as possible, enclose the anodes in porous cells, replace the electrolyte daily, clean the anodes frequently by brushing in dilute HCl, keep the electrodes quiet and the electrolyte unagitated, protect the surface of the bath from the air by a layer of paraffine, keep the current below the higher limit named, use cathodes carefully cleaned and greased, use an electrolyte free from carbon. A sulphate electrolyte will always give iron deposit with a little sulphur—0.006 per cent when using perfectly pure anodes. The deposits contained also 0.012 to 0.014 per cent of hydrogen and 0.010 to 0.035 per cent of nitrogen. When such specimens were heated they showed numerous points of disengagement of heat, due to the reactions of hydrogen, but these disappeared on repeated heatings. The critical points showed distinctly at 894° and 761°. The fusion point was determined on a specimen containing 0.017 per cent C, 0.089 Si, 0.028 P, 0.025 Mn and 0.037 S, by heating in vacuum in a magnesia crucible, as between 1485° C. and 1525° C.

Recovery of Flue Dust.

Friction System.—Mr. Charles W. Goodale, of Butte, Mont., contributes an interesting note to the discussion of Mr. D. W. Bronton's address on modern progress in mining and metallurgy in the Western United States. It is printed in the January issue of the *Bulletin* of the American Institute of Mining Engineers. Mr. Goodale describes the friction system designed for the recovery of flue dust from furnace gases as used at Great Falls. Screening tests on the blast furnace charges of smelting ore, and on the fine concentrate treated in the McDougall furnaces, show a high percentage of fine material, which would naturally be carried into the flues, and at a high velocity of the furnace gases through the flues a considerable loss in dust would inevitably occur.

Before deciding upon the friction system a flue was built 300 ft. long, 4.5 ft. high and 4 ft. wide, through which the furnace gases could be drawn in measured volume and temperature, and at varying velocities. Two tests were made maintaining a velocity of about 500 ft. per minute, and with no obstructions or dust arresters in the flue. The amount of dust was determined per unit volume of gas; then similar determinations were made with baffle plates, Freudenberg plates (of sheet iron, suspended parallel with the direction of the flow of the gases), with numerous contractions and expansions, and with wires (patented by Roesing in the United States in 1890). It was found that the wires gave nearly as high an efficiency of dust recovery as the baffle plates, and with very much less frictional resistance to the passage of the gases. It was then decided to build a dust-chamber of such dimensions that the furnace gases would not have a velocity greater than 500 ft. per minute through it, and to fill this chamber with steel wires.

All the furnace gases from the several departments are assembled through individual flues in an up-take in the furnace building. From the top of this take-up a cross-take leads over the smelter buildings and tracks to the dust chamber. The cross-take is 34 ft. wide and 20 ft. high. The main dust chamber, rectangular in shape, is 367 ft. long, 176 wide, 21 ft. high. Steel-wire netting, 1⅝-in. mesh, is bolted to the I-beams of the roof, and at alternate intersections of the netting wires, steel dust arresting wires, No. 10 gage, weighing about 1 lb. each and reaching nearly to the floor of the chamber, are hooked on. From the entrance to the chamber, and for a distance of about 150 ft., the space is fully occupied by wires; then comes a length of about 50 ft. with no wires, then 150 ft. filled with wires. In the vacant space, air ducts, both from the basement and the roof, are provided, so that the temperature from that point on can be reduced and the condensation of arsenic effected on the wires.

The purpose of this arrangement is to collect, as far as possible, the dust which is carried along mechanically by the furnace gases in the first part of the chamber, which leaves the condensable elements to be recovered in the upper part. Experience has shown that at or below the condensing temperature of arsenic the wires become heavily coated, and it is therefore necessary to shake them. Provision has been made for this. The dust chamber is divided longitudinally by a partition wall, and dampers placed at the lower and upper ends of the chamber make it possible to deflect all the gases through either half if it is so desired. Leading from the dust chamber to the chimney, which is 506 ft. high and 50 ft. in diameter at the top, is a flue 1200 ft. long, 48 ft. wide and 21 ft. high.

In the floor of the dust chamber there are more than 1000 sheet-steel hoppers, arranged in 22 lines, and a complete system of tracks enables the dust to be drawn from any hopper at any time. The cross-take is also provided with hoppers, and a hopper crane draws off the dust and conveys it to chutes leading down into the bottom of the up-take, where there are hoppers from which the material can be drawn into the charging cars for the reverberatory furnaces. There are 1,215,000 wires in the dust chamber, weighing about 608 tons, and nearly 3500 tons of structural steel in the flue system. Recording thermometers and pressure gages have been placed at the entrance and exit of the dust chamber and in the flue near the chimney, so that complete information regarding conditions is available.

Precious Metals.

Assay of Gold Alloys.—At the meeting of the Institute of Metals, Jan. 18, in London, Mr. Ernest A. Smith presented a paper on the assay of industrial gold alloys. In this paper Mr. Smith gave a brief description of the methods in general use for the assay of industrial gold alloys, and embodied the results of experimental work carried out some years ago at the Royal School of Mines, and more recently in the Metallurgical Department of the University of Sheffield. The alloys dealt with are those of definite composition or "standard" alloys specially prepared for industrial purposes, and also those of more or less indefinite composition resulting from the treatment of scrap, lemel, sweep, and such substances obtained during the processes of manufacture.

After giving examples of the composition of some of the alloys in general use by goldsmiths and jewellers, which are

mainly ternary alloys of gold-silver-copper, Mr. Smith discusses the various methods of sampling and the precautions to be taken in the case of alloys in which segregation has taken place. Attention is drawn to the importance of removing the "colored" surface resulting from the "pickling" before taking the samples for assay. When this "colored" or enriched surface is included in the sample very serious errors may be introduced into the assay results in the case of sheet metal and wire.

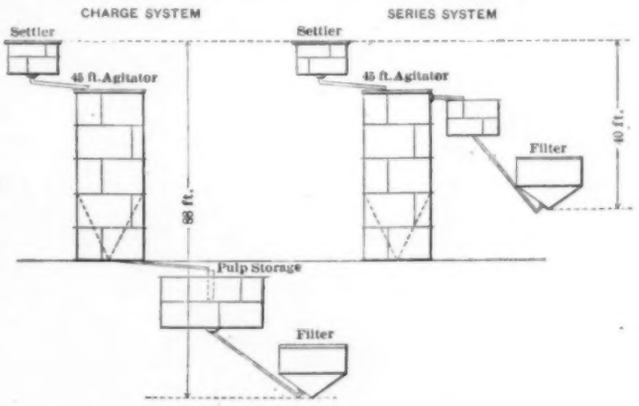
The question of the best proportion of lead to be used for the cupellation of gold alloys is then considered, attention being drawn to the fact that copper has a greater affinity for gold than for silver, consequently a larger proportion of lead is required to ensure its oxidation when combined with gold than when combined with silver. It is also pointed out that the separation of copper from gold is greatly facilitated by the presence of silver.

The quantities of lead used by different assayers experienced in assaying these alloys are given in a table. Brief reference is made to the methods in general use for charging the assays into the furnace, and the results of experiments on adding the lead in two separate charges (viz.: adding one-third after the other two-thirds have worked off).

The chief item of the paper is the comparison of the assay methods used for industrial alloys, based on experimental work, and it is shown that the results for the gold assay are invariably higher when determined by direct-cupellation with parting silver than when determined indirectly by double cupellation. The importance of using check assays in all cases where extreme accuracy is desirable is emphasized by Mr. Smith. The method of double cupellation, or "parting-assay," in which the gold and silver are determined in the same assay piece, is largely used by trade assayers for the valuation of lemel bars, and like substances, and in the hands of experienced assayers the results are sufficiently accurate for commercial purposes. In making assay by this method, it is well to remember that it is the weight of the gold which is the most important, because of its value, and the working conditions should be such that no undue loss of gold is occasioned. The different methods of reporting assay results are referred to. The decimal system is now very generally adopted for reporting gold assays, but the older "carat" system is still in use, as the generality of workers and dealers in gold and silver are more conversant with this system of computation than with the decimal equivalent. (From advance sheets.)

Cyaniding Slime.—In the January issue of the *Bulletin* of the American Institute of Mining Engineers, Mr. MARK R. LAMB discusses the two methods of treating pulp in air-agitation tanks. The usual method is to fill each tank in turn, agitate the mixture the required period and then discharge the treated pulp into a storage tank, from which it is drawn to the filter as required. A second and later method is to run the pulp from the tube-mill, classifier, thickener or settler into the first of a set of tanks, and thence continuously or in series through the remaining tanks, finally drawing off the pulp to a continuous filter, or to a pulp-storage tank if the filter is of the intermittent type. Mr. Lamb emphasizes the advantages of the latter method and mentions that in the design of a recent cyanide plant the estimated cost of agitation tanks, storage tanks and pumps was 30 per cent higher for the charge-agitation arrangement than for the series plan. An objection which might be raised against the series method is that some of the pulp might get through with little or no treatment. The author shows by simple approximate calculation that this is out of the question and that it is physically impossible for any particle of the pulp to go through the series of tanks in less than a certain minimum period. This minimum period gives the series method a big handicap, and one which increases directly with the number of tanks used. In fact, the resulting low circulation velocity makes the operation resemble the treatment of pulp in a horizontal tube of the same diameter as the agitation tanks and of a length equal to the combined lengths, having the agitation at right angles instead of parallel to its length.

Mr. Lamb mentions some interesting results obtained in tests on a small scale, with tanks of a capacity of 100 lb. of dry slime in a 2-to-1 pulp. With pulp containing coarse sand (and even with fine sand in a thin pulp) care must be exercised in drawing the pulp from one tank to the next in series, otherwise either the sand or the slime will accumulate. If the drawing-off pipe is merely flanged to the tank, the outflowing pulp will contain a greater proportion of slime to sand than is



CHARGE AND SERIES SYSTEMS OF CYANIDING SLIME.

contained in the average of the pulp, since during agitation by this method the sand has a tendency to sink through the pulp as soon as discharged through the central air-lift, rather than to work out to the sides of the tank with the flocculent slime. This difference in pulp flow is greater with a thin mixture and less with a thick one, and can be utilized practically in a very simple manner if it is desired to agitate the sand longer than the slime. A concentration of sand in the tank will be attained by drawing the slime from a quiet point in the circumference of the surface of the pulp. To do this, a discharge pipe, pivoted at the side of the tank, is arranged to swing in a horizontal plane and to be placed and held at any desired point in its arc between the central pipe and the side of the tank. After the desired initial concentration is attained, this discharge pipe is then placed so as to draw off a mixture of the same proportions of sand and slime as that being fed to the tank, which will maintain the charge in the tank at a higher ratio of sand to slime. Thus the slime will go through faster and the sand slower than the average pulp flow.

To illustrate this point, imagine a tank containing 100 tons (dry weight) of pulp consisting of 3 of sand to 1 of slime. Admit a stream of pulp carrying 100 tons in 24 hours, which consists of half sand and half slime, drawing off an exactly similar stream. The slime which was originally in the tank (25 tons) will be replaced twice in 24 hours, by the 50 incoming tons, while the original sand (75 tons) will be replaced in only two-thirds time. In other words, the slime will receive a 12-hour treatment and the sand will receive a 36-hour treatment. Mr. Lamb considers this one of the important advantages of the "series" system.

A point of great advantage possessed by the series method in the design of many plants is the saving in difference of level required in the site. The agitation tanks, if used in this manner, need not require more than from 2 to 4 ft. difference in level between the inlet and the outlet, depending to some extent upon the number and size of tanks and the distance apart, but also and mainly upon the margin of capacity required to provide for fluctuations in pulp feed and discharge. This margin depends largely upon the type of filter used. Ordinarily, the pulp will be

drawn from near the top of the last tank, while in the "charge" system the outlet is at the bottom of the tank. The accompanying figure shows this difference.

In the series system no storage tank is needed below the last agitator tank if a continuous filter, such as the Oliver or the Ridgway, is used; only a small tank of a capacity to supply pulp to equal displacement of a loaded basket of leaves if a Moore filter is used, and a slightly larger tank (sufficient to fill the filter box with the unloaded frames in place) with a Butters filter. On the other hand, in the charge system the storage tank, even with continuous filters, must have at least a capacity equal to that of an agitator, and with either the Moore or the Butters filter must have a slightly greater capacity.

Continuous Collection of Sand for Cyaniding.—With respect to Mr. W. A. Caldecott's paper, abstracted in our January issue, page 42, Mr. C. O. Schmitt makes some eulogistic remarks in the *Journal* of the Chemical, Metallurgical and Mining Society of South Africa of November, 1909. He thinks that Caldecott's process represents a real advance in the treatment of sand. The satisfactory collecting of the sand contained in the final pulp leaving the battery, preparatory to treatment, is by no means a simple proposition. It is obviously necessary, in order to facilitate treatment, to collect the sand free from all slime, but this is not by any means always done, the slime contents of collected sand being sometimes as high as 10 per cent. Slime pulp should be treated in the plant provided for the purpose, and since the treatment of slime is, as a rule, less expensive than the treatment of sand, any slime retained in the collected sand not only costs more to treat than it otherwise would, but it also displaces sand which could be handled in its place, quite apart from the fact that the presence of slime in the sand-collecting vats interferes with the treatment. Mr. Schmitt emphasizes the excellent results obtained on the Simmer and Jack plant, using a 15-ft. table, although it is only of an experimental nature. The objection might have been raised to the introduction of further machinery into the already complicated reduction plant, but Mr. Caldecott has disposed of any such objections by pointing out that the continuous running of the filter table presented no difficulties; so much so that the arrangements made for temporarily reverting to the old style of working, in case of temporary failure, have not so far been needed.

The four chief advantages of the Caldecott process are summarized as follows: The sand collected is cleaner and contains less slime than is the case in the ordinary plant. The capital cost of the sand plant has been reduced by nearly 40 per cent. The space occupied by a sand plant has been reduced. The time of treatment is reduced to about two-thirds of that now occupied. The question of capital expenditure will appeal to most, and since the saving of 40 per cent on the sand plants amounts to about 10 per cent on the whole reduction plant the result accomplished is worthy of considerable praise. The saving on capital account may be still further increased by providing only one set of treatment vats, and while this may not be acceptable for very high-grade propositions there will be many instances where it could be justified.

The tendency all over the world is toward all sliming, and in view of the ease with which the average slime is treated, this is, in many cases, quite justified. "In view of the result obtained it is obvious that Mr. Caldecott has done quite a good deal toward the desired end, and (in the writer's opinion) more than those who propose to spend a shilling in crushing and grinding, to save sixpence in the cost of the succeeding treatment. We are not by any means at a stage where the sand plant can be discarded," and in this connection the writer refers to an all-sliming plant erected by Mr. Charles Butters in Mexico which in spite of being intended as an all-sliming plant contains a sand plant. The reason is that upon work having been started, it was found that the product from the crushing and grinding plant did contain what is usually termed sand and which did not yield sufficient of its precious metal contents.

Copper.

Cartridge Brass is the subject of a very interesting study by Capt. Grard, published in the *Revue de Métallurgie*, October, 1909. As is probably generally known, this brass must sustain great mechanical strains in being stamped or drawn into shape, and only the best copper and the very finest zinc can be used in it. It is usually made with 33 per cent zinc. Exhaustive mechanical tests were made with the brass as cast, worked, partially annealed and annealed, while an extensive microscopic study was simultaneously made. It was determined that from 0° C. to 250° C. this brass possesses its minimum of malleability; when worked, the structure showed broken octahedral crystals. Heated to from 250° to 400°, the normal properties commence to appear. Between 400° and 700° is a range for semi-annealing; heated between these limits the tensile strength diminishes gradually, but the elongation before rupture increases. Complete annealing is attained by heating to between 750° and 830°, but the upper limit must be approached circumspectly; slight impurities in the metal and possible errors in determining the temperature both make it advisable to keep below 800°. Annealing above this temperature causes a rapid falling off in the quality of the metal.

Failure of Brass Loco-Tubes.—At the meeting of the Institute of Metals, in London, Jan. 19, Mr. T. Vaughan Hughes presented a paper on the failure in practice of non-ferrous metals and alloys, with particular reference to brass loco-tubes. The paper describes an investigation into the cause of a breakdown of brass loco-tubes which led to serious casualties and Government inquiry. The breakdown occurred at the firebox end of the tubes nearest the firebox. The tubes were not corroded externally, but were thus affected internally, mostly along a semi-diameter. The corrosion appears to be the result of the action of volatile sulphur compounds from the fuel used (coke) in presence of hot reducing gases, which may have volatilized the zinc from the internal surfaces of the tube alloy. Condensed water vapor of an acid nature cleared the tubes during the morning stoking and at other times, allowing a repetition of above actions. Thus the tubes wore down internally until too weak to withstand the working pressure in the boiler. The action was by the author's further investigations found to be facilitated by the peculiar nature of the "scale," only 1/20 of a millimeter thick, which offered a resistance of 20 megohms to an e.m.f. of 250 volts when dry, and 150,000 ohms when wet.

This electrical measurement was taken as being indicative of the heat conductance of the "scale," and explains an overheating of the tube at the seat of breakdown and other parts. The "scale" consisted largely of silica, magnesia and ferric oxide, combined with a small amount of sulphuric acid initiated and held together by a soap of iron, aluminia and magnesia. The breakdown only occurred when the boilers were fed with untreated water supplied from a peaty source. Analysis of the "scale" and other data are briefly given. (From advance sheets.)

Aluminium.

Analysis of Aluminium and its Alloys.—A paper by Dr. R. Seligman and Mr. F. J. Willott was presented at the annual meeting of the Institute of Metals, in London, Jan. 18. The rapid development of the aluminium industry makes it desirable that everything appertaining to it should be standardized, among other things the methods of analyzing pure aluminium and its alloys. The technical methods described in this paper have been in use for a number of years, and it is hoped that they may form the basis for a future standard course of analysis. The aluminium of commerce contains from 0.15 to 0.6 of iron, 0.2 to 0.7 of silicon, and 0.02 to 0.06 of sodium, together with traces of carbon, oxygen and nitrogen, while occasionally small quantities of copper are found. The purity of the metal varies from about 98.5 up to more than 99.75 in exceptional cases. Owing to the impossibility of estimating the aluminium itself with sufficient accuracy, it is customary

to determine all the impurities and to calculate the purity of the metal from the figures so obtained. In most cases, only those impurities present in appreciable quantities are estimated, a course which has been fostered by the general ignorance of the influence of the minute quantities of the ingredients thus ignored on the properties of the metal. It is hoped that information will shortly be forthcoming as to the effect of these materials on the metal, so that the methods will have to be modified in this respect. A detailed description is given of methods of estimating silicon in its various forms, iron and sodium, together with figures indicating the accuracy of the various determinations.

The alloys of aluminium in common use contain, in addition to the impurities cited above, copper, zinc, nickel and magnesium, and as an additional impurity, lead. Alloys containing tin are met with in the form of solders or soldered joints. The methods which the authors use for determining these ingredients are described. Occasionally manganese, titanium and tungsten have to be dealt with, and the determination of these elements is briefly referred to, because the authors are of the opinion that the closer study to which these alloys are being submitted will enhance their importance and promote their wider introduction. (From advance sheets.)

Alloys.

Phosphor Bronze.—A paper by Messrs. O. F. HUDSON and E. F. LAW, on phosphor bronze, was presented at the meeting of the Institute of Metals, in London, Jan. 18.

The object of the authors' work is to indicate the relation between the mechanical and other properties of the copper-tin-phosphorus alloys and their constitution and structure. Copper and phosphorus combine with the formation of a definite phosphide of copper, which forms with copper a binary eutectic, and a ternary eutectic with copper and the compound Cu_4Sn. With less than 4.5 per cent of tin the slowly cooled alloys consist of copper holding in solution the tin and, perhaps, a small amount of phosphorus, and of copper phosphide in rather large but fairly uniformly distributed masses, there being no sign of the typical eutectic structure. With more than 4.5 per cent of tin the ternary eutectic, having the composition 81 per cent copper, 14.2 per cent tin, and 4.8 per cent phosphorus, and a melting point of 620° C., makes its appearance.

A diagram was given showing the constitution of all the alloys containing up to about 25 per cent of tin. For practical purposes the phosphor bronzes may be divided into two classes, (1) the malleable phosphor bronzes containing relatively small amounts of tin and phosphorus, not more than about 6 per cent of tin and 0.3 per cent of phosphorus, and (2) the cast phosphor bronzes containing in some cases as much as 12 per cent of tin and 1.5 per cent of phosphorus. The malleable phosphor bronzes consist of a homogeneous solid solution of tin and phosphorus in copper, or they may contain some phosphide of copper in the form of small rounded particles evenly distributed throughout the mass of the alloy. The cast alloys contain the ternary eutectic with some phosphide of copper. The ternary eutectic is exceedingly hard, while at the same time it possesses a good crushing strength, and it is to this constituent that the phosphor bronzes owe their property of resisting wear. The paper includes notes on the examination and analysis of the phosphor bronzes, and is illustrated by a number of photomicrographs illustrating the structure of the alloys. (From advance sheets.)

Copper-Arsenic Alloys.—A paper by Messrs. GUY D. BENGOUGH and B. P. HILL, on the properties and constitution of copper-arsenic alloys was presented before the Institute of Metals in London on Jan. 19. The paper is divided into two parts; the first deals with the mechanical properties of the alloys of industrial importance, the second with their chemical constitution.

In the first part the authors begin by stating the most important purposes for which these alloys are used, namely for locomotive parts and for dynamo brushes. They also give a statement of what are generally considered to be the peculiar characteristics of the alloys as compared with pure copper, namely, greater strength and rigidity, and greater resistance to the action of flames, i. e., of gases at high temperatures. The best proportion of arsenic to be used to insure maxima of the advantages named was shown to be a matter upon which opinions differ widely, and one of the principal objects of the paper was to bring forward data for an authoritative pronouncement on the matter. For this purpose five 1-in. round copper bars containing amounts of arsenic varying from 0.04 per cent to 1.9 per cent were prepared under ordinary industrial conditions by the Muntz Metal Company, and were thoroughly tested by the authors in three conditions, namely: (1) As rolled; (2) after being heated for various lengths of time in an oxidizing atmosphere; (3) after being heated for similar times in a reducing atmosphere. The reducing gases used in the third set of tests were coal gas, hydrogen and carbon monoxide. Since these gases are liable to come in contact with the copper-arsenic alloys used in practice in locomotive firebox construction, it was thought that an interesting light might be obtained on the causes of deterioration and failure of the alloys in practice.

Upwards of a hundred tensile tests were made to ascertain the exact conditions under which the mechanical properties of bars containing 0.04, 0.26, 0.75, 0.94, 1.94 per cent of arsenic respectively were spoiled by contact with gases at high temperatures. Briefly, these conditions were found to be: (a) Alloys containing between 0.04 and 1.0 per cent of arsenic were ruined by the action of reducing gases for three hours at 700° C.; in some cases a temperature as low as 600° C. was sufficient. (b) Similar alloys were not harmed by identical treatment in an oxidizing atmosphere, nor when the temperature was raised to 900° C. (c) Alloys containing 1.9 per cent of arsenic were not harmed by treatment in either an oxidizing or a reducing atmosphere.

With regard to the best percentage of arsenic to use in these alloys, the authors found that the alloying metal when present in quantities less than 2 per cent tends to increase slightly the tensile strength and the elongation of their alloys. They also consider that the homogeneity and the resistance to the action of reducing gases increase with increased percentage of arsenic up to 2 per cent.

The authors describe a series of experiments carried out to elucidate the *modus operandi* of the reducing gases in spoiling the alloys, and put forward tentative suggestions as to the means which might be taken to produce bars which would resist the action of reducing gases.

In the second part of the paper the authors describe the work undertaken to elucidate the constitution of these alloys, and give a diagram illustrating it under certain defined conditions. They confirm the existence of the compounds Cu_3As, and Cu_5As_2, already proposed by Friedrich, and deny the existence of the compound Cu_2As, proposed by Hiorns. (From advance sheets.)

Electrochemistry.

Fixation of Atmospheric Nitrogen.—In *Zeit. f. Elektrochemie*, Jan. 1, a review is given by F. HABER and A. KOENIG of the present status of fixation of atmospheric nitrogen. The following table sums up the results obtained with the three successful processes in commercial operation; the process of the Badische Company (Dr. Schönherr) (see our vol. VII, p. 245), the process of Birkeland and Eyde (see our vol. IV, p. 126 and VII, p. 304) and the process of Salpetersäure-Industrie Company (Pauling) (see our vol. VII, p. 430). The table gives both the yield in grams HNO_3 per kilowatt hour and the con-

	Grams HNO_3 per kw-hour.	Concentration in per cents NO.
Badische Company	75	2.5
Birkeland and Eyde	70	2
Pauling	60	1 to 1.5

centration in per cents of NO, since both items are of fundamental commercial importance.

The comparison with theoretical figures is difficult. The commercial yield of the process of the Badische Company is about 63 per cent of the theoretical value obtainable (without regeneration of heat) on the hypothesis that the oxidation of the nitrogen is a purely thermal process and that the temperature of the arc is 3800 deg. C. The authors give a very useful review of the various scientific investigations made in recent years on the mechanism of the oxidation of atmospheric nitrogen by electric discharges through air.

Calcium Carbide and Acetylene Tetrachloride.—A report by J. H. Vogel on the present situation of the calcium carbide industry in Europe is given in abstract in *La Revue Électrique*, Nov. 15, 1909. While in the past the consumption of calcium carbide in Germany has increased from year to year (30,340 tons in 1906, 34,916 in 1907, 39,180 in 1908), there is a decrease to 38,000 tons in 1909, due to the introduction of electric instead of acetylene lighting on the cars of the Prussian railways. With this single exception the consumption of carbide has further increased. During the past year dissolved acetylene (see our Vol. I, page 274) has been introduced in Germany. The manufacture of acetylene tetrachloride is now carried out on a large scale by the simple addition of chlorine to acetylene, without using any further compounds. It contains about 85 per cent of chlorine and 15 per cent of acetylene, and its manufacture is advisable where cheap chlorine is available. Since 1 kg of commercial carbide yields 1/3 kg of acetylene (285 liters) there are needed 85 kg of chlorine for 45 kg of carbide to produce acetylene tetrachloride. This is an excellent solvent and is used as a substitute for benzine and like materials, its great advantage being its non-inflammability. It is also made in Jaice (Bosnia) and in Runcon (England); at the latter place a plant capable of producing 1000 cu. m of acetylene per day has been erected. At both places, the process of the Consortium f. elektrochem. Ind. is employed. Another process has been worked on an experimental scale in Neustassfurt and is about to be started on a large scale. A derivation of acetylene tetrachloride is trichlorethylene, C_2HCl_3, which is a substitute for carbon tetrachloride. The latter has the disadvantage that it attacks iron at elevated temperatures. Trichlorethylene is made in Jaice in Bosnia and sold in carloads. The long experiments on the utilization of acetylene for the manufacture of lamp black appear to have been successful; in a plant at Friedrichshafen 1000 tons of carbide will be treated per year. This plant has a contract with the Zeppelin Company for the supply of large quantities of hydrogen for airships.

Bleaching Liquor by Electrolysis with Magnesium Cathodes.—The direct production of hypochlorite or bleaching liquor by electrolysis of alkali chlorides, depends on a good mixing of the anodic and cathodic products of electrolysis. The efficiency of this process is reduced by the production of chlorate and anodic oxygen and by the reduction of hypochlorite at the cathode. To prevent the latter the only remedy is to keep the ClO ions away from the cathode. By a well-known process of Imhoff and Müller this is accomplished by an addition of chromate to the electrolyte; this has such an effect that a very thin yet effective diaphragm forms automatically at the cathode surface thus preventing the ClO ions from making contact with the cathode. Betts and Sherry have proposed the use of magnesium cathodes. In the October, November and December issues of 1909 of *Elektrochemische Zeitschrift* M. F. Schmidt gives an account of an investigation in which he studied the reason for the good effect of the magnesium cathode. It is again the automatic formation of a very thin diaphragm right on the cathode. As soon as the magnesium plates are inserted in the solution they are covered with a film of magnesium hydroxide which prevents the ClO ions from making contact with the cathode. From a commercial point of view it is to be considered that on account of this film the internal resistance of the cell is increased. With a current of 1.6 amp, in the author's experiments, the voltage was 1.1 volt higher with the magnesium cathode than with one of platinum. Further the formation of chlorate increases with increasing concentration of ClO. With respect to the efficiency, the use of a magnesium cathode differs from that of a platinum cathode of the same size in so far as the same or a somewhat higher yield of active chlorine may be obtained with magnesium by more watts in a shorter time. But by increasing the magnesium cathode it is possible to decrease the voltage (and therefore the power) and nevertheless obtain a high efficiency.

Ozone.—According to a note taken from *Revue d'Électrochemie et d'Électrométallurgie* and printed in the London *Electrical Engineering* of Dec. 30, ozone prepared by electric discharges through air is sometimes found to contain oxides of nitrogen, and Boujeau has noticed the action of these oxides upon the lead pipes which conducted the ozonized air in water purification works. As a result, nitrate of lead has been found to contaminate the water, which is naturally a serious matter. For this reason it is recommended never to employ metallic pipes for conveying the ozone from the ozonizers to the sterilizing plant. As an indication of further progress made in the industrial sterilization of water by ozone, it is stated that at the town of Chartres, in France, drinking water is now obtained by purifying, with ozone, water from the Eure River. This contains originally from 3000 to 16,000 bacteria per cubic centimeter, but treatment with 2 grams of ozone per cubic meter of water renders it practically sterile. The installation, employing the Otto system, is a double one, each part being capable of sterilizing 6000 cu. m (212,000 cu. ft.) of water in 24 hours. A 40-hp steam engine raises the water a height of 11 m (36 ft.) and drives a 500-period 250-volt alternator. The voltage is then raised by a transformer to 20,000. The ozonizers have glass plates as dielectrics, with tin foil between them, and the air is passed between the plates; 50 watt-hours are required to produce 2 grams of ozone, and as this is sufficient to sterilize 1 cu. m of water, 12 kw are required for the 6000 cu. m in 24 hours. A project is stated to be on foot to sterilize Paris water in a similar manner, when it is hoped it will be possible to set up a plant which will be capable of sterilizing 1 cu. m of water with an energy consumption of 10 watt-hours.

Electric Vacuum Furnace Installation.—In our vol. IV, p. 223 (see also vol. VII, p. 427), an electric vacuum furnace of Arsem for experimental work was described with a vertical graphite helix as heater, in the center of which is the crucible. The "radiation screen" (a device for diminishing the loss of heat by direct radiation from the heater) is an annular graphite box, filled with graphite powder which is a poor conductor. In the January issue of the *Journ. of Ind. & Eng. Chemistry* of the American Chemical Society Mr. W. C. Arsem describes some modifications of this design. A larger size of the vertical type differs only in size and in details from the above. In the horizontal tube furnace the heater is a graphite tube, held in graphite clamps with a tight sliding fit, to permit expansion and contraction. Finally in the "box, type" of tube furnace the chamber is a rectangular gun-metal box with a removable cover. The heater is made up of four graphite grids, connected in series. These grids are made by sawing slots in graphite slabs 5 in. x 18 in. x ¾ in. The heated space enclosed by the grids is large enough to take a box-shaped crucible 4 in. wide, 12 in. long and 8 in. high, or 384 cu. in. The radiation screen is made up of eight box-like sections, each hollow and filled with graphite powder, the top section being removable. The research laboratory of the General Electric Company has two installations of vacuum furnaces each containing four furnaces with the necessary transformers, pumps, etc. A very convenient installation for small scale experimental work would consist of a small vertical-type tube furnace, a 10-kw flux-shunt transformer, a Geryk pump and a 15-kw wattmeter.

Electric Furnace Temperature Regulation.—A contrivance to maintain a regular temperature in an experimental electric

Physique by Mr. L. Kolowrat (also in London *Electrician*, December 31, 1909). In Fig. 1 is a resistance furnace fed by current from the mains *A*.

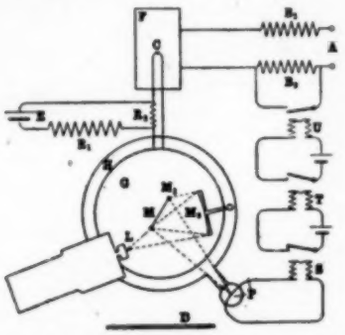


FIG. 1, APPARATUS FOR TEMPERATURE REGULATION.

The thermo-couple *C* is connected to a Le Chatelier galvanometer *G*, which carries on its movable part, in addition to the concave mirror *M* indicating on the scale *D*, a thin, flat glass mirror, 4x3 cm. in size. *L* is the filament of a Nernst lamp placed vertically, M_2 a spherical mirror with a gilt outer surface, and *P* is a Rubens thermoelectric cell, consisting of 12 copper-constantan elements. The position of the mirrors is so arranged that, when the temperature of the furnace reaches a determined point and the arrow of the galvanometer consequently registers at a certain angle, the rays of the lamp are focused on the junctions of the thermo-electric cell *P*. The current generated in the cell acts on a system of three relays, *S*, *T*, and *M*, which operate successively. By this means a resistance is introduced into the circuit *A*, and the heat of the furnace is consequently diminished. When this happens the deflection of the galvanometer decreases, the concentration of rays is removed from the cell *P* and the relay system shunts B_3.

The range within which the temperature of the furnace may be confined may be decreased by increasing the sensitiveness of the galvanometer.

Randall in the *Physical Review* (Vol. XLV, page 142) has described a furnace, the regulation of which can be accomplished by means of a thermo-couple attached to a galvanometer. This latter acts as a relay, but the principle involved is quite different from that of the apparatus just described.

Chemical Engineering.

Concentration of Sulphuric Acid.—In the *Chemiker Zeitung* of Jan. 11, Dr. G. LÜTTGEN remarks that the hopes which have been placed in the contact process for making sulphuric acid have not been completely fulfilled in the course of the last years. It had been wrongly supposed that the lead chamber process was doomed. The numerous difficulties of the contact process have not yet been overcome. The process is still very sensitive. On the other hand, various improvements have been made in concentration apparatus for chamber acid. These apparatus not only serve for increasing the concentration of the chamber acid (in some cases up to 98 per cent H_2SO_4), but they also permit the regeneration of the weak acids formed in some processes.

The first system discussed makes use of two series of 20 porcelain pans, arranged stepwise. The acid passes from one pan into the next. At the lower end a coke fire is provided by which the pans are heated. This system had the disadvantage that the porcelain pans were very liable to break. It has been improved by the use of pans of acid-proof metal or fused quartz; the loss by breakage has been reduced, but it still exists. The disadvantage of these pans is that they permit acid to trickle through, since after a certain time microscopically small cracks are formed. During the course of the last few years a coke filter has been added to this system. The acid obtained by this treatment is clear and may be easily concentrated to 92 or 93 per cent H_2SO_4. The consumption of coke is fairly high, about 150 kg (330 lb.) per ton of 92-93 per cent H_2SO_4. To pass the acid vapors into the coke filter, a small ventilator is used; the power required is small, amounting to ¼ hp for one hour and one ton of concentrated acid.

In the second system described a tower is used into which hot gases enter at the bottom, while at the top the chamber acid (52 to 53 deg. Baumé) is introduced in the form of a spray. Under the effect of the heat the acid mist is concentrated and the acid passes out of the tower at a concentration of 92 to 93 per cent. The steam mixed with acid escapes at the top. The ("volvic" stone) tower may have a height of 7 to 15 meters (23 to 49 ft.). The acid is injected in the form of a spray by means of a lead injector with a circular end-piece of cast iron with a nozzle in the center. This nozzle must be adjusted to the desired degree of concentration of the acid. It is therefore always necessary to change the nozzle whenever the degree of concentration of the acid is to be changed. There are therefore different nozzles used for 78 to 80 per cent, for 92 to 93 per cent and for 96 to 97 per cent acid. The inside of this injector contains a part in the form of a spiral which ends at the front in a point, and at the back in a cylinder. When the chamber acid is forced through this spiral passage, it assumes a rotating motion and leaves the nozzle in form of a rotating mist which fills the whole inside of the tower.

The weak point of the method is that a very pure acid is required which is taken from the second chamber and must be filtered very carefully, since any small impurity would clog the spray nozzle, or, at least, clog it partially. In the latter case the acid is not set into rotary motion, but is thrown in a straight thin stream against the tower walls. The acid becomes turbid and colored. In such a case the apparatus must be stopped and the spray nozzle must be cleaned. But this takes some time, since the attendant will not become aware at once of what has happened and a large quantity of dark acid may have formed meanwhile.

To remedy this the chamber acid is passed through a large sand filter, but this is not always successful. For the condensation of the acid vapors two filters are connected to the apparatus. Both may be filled with coke, but the second is generally filled with quartz. Between the tower and the first coke filter there is inserted a nine-meter lead column to cool the acid vapors and condense them partially. The movement of the gases is obtained by a ventilator at the end of the apparatus. The temperature in the upper part of the tower is 120 deg. to 140 deg. C., while the temperature in the upper part of the lead column is 90 deg. to 100 deg. C. This apparatus with its latest improvements requires 110 to 120 kg of coke per ton of 92-93 per cent commercial acid. The power required for operation is 0.75 hp per hour per ton of concentrated acid. The output of a plant of usual size is 10,000 kg of 92-93 per cent acid in 24 hours. The quantity of acid from the coke filter is also quite considerable. In 24 hours about 2000 kg of acid at 10 deg. Baumé and 500 kg of acid at 14 deg. Baumé are obtained. The price of such a plant when completed is 40,000 to 50,000 marks ($10,000 to $12,500). Since there are only a few plants of this kind in use and these have been in operation only a short time it is too early to give exact figures regarding the cost of maintenance, but the author thinks the repairs will be somewhat expensive. The third system discussed by the author (an improvement of the old Kessler system) will be dealt with in our next issue.

Pyrometry.—In the work on pyrometry, carried out by the Reichsanstalt in 1908, as noticed in London *Engineering* of Dec. 17, 788 thermo-couples were tested; 691 of these were of the Le Chatelier platinum, platinum-rhodium type. The electromotive force of these couples decreases when the couples are exposed to very high temperatures for many hours, and the whole length of wires for a new couple was therefore wound on a magnesia tube, without allowing the two wires to come into contact, and heated to 1400° C. in an electric furnace. Carbon, silicon and iridium, which had been held responsible for the change, were absent in these experiments.

It would appear that some of the rhodium evaporates and settles on the platinum wire, causing a change in the electromotive force, which, at the end of four hours, was equivalent to 35° C. This confirms an observation made by W. P. White in 1906, who found rhodium in the originally pure platinum wire. The effect is local and confined to those portions which are exposed to the highest temperature; that would explain the dependence of the electromotive force upon the depth to which the couple is inserted. The number of constantan-silver couples tested by the Reichsanstalt has diminished and there is a prejudice against their constancy. Repeated tests, during which such couples were heated for 12 days, finally to 600° and 650° C., did not bring out any discrepancy; the indications remained constant within 1 deg. The want of constancy may be due to the arrangements used in engineering practice. The standardization of the Wanner optical pyrometer (35 of these were tested) against black bodies by means of the Koenig and Lummer-Brodhun pyrometer is difficult, on account of the temperature determination in the black body by the aid of thermocouples. In the work on Seger cones, iridium, iridium-ruthenium couples and a tubular iridium furnace are used. Twenty cone temperatures have now been fixed; cone No. 20 has a softening point of 1530° C. But the research had to be interrupted because the iridium tube had to be repaired again.

Alcohol From Sawdust.—Concerning the manufacture of alcohol from sawdust in a plant at St. Marcel, Department of Ardeche, in Southern France, a recent consular report of Frank H. Mason, of Paris, states that this is a new, up-to-date concern and employs a process which consists in exposing sawdust to sulphurous acid gas, whereby the alcohol is generated and extracted without being mixed with or contaminated by the sulphur, as had always happened when sawdust was macerated in a solution of sulphuric acid under the older processes. Consequently it is claimed that alcohol made by the new process can be taken internally or used for any other purpose to which pure alcohol is usually applied.

One metric ton (2204 pounds) of sawdust yields by this process 100 liters (27.47 gallons) of alcohol, 20 kilograms (44 pounds) of acetic acid, and the residue or spent sawdust is pressed into briquettes and used as fuel.

Recent Metallurgical and Chemical Patents

Non-Corrosive Dead-Soft Open-Hearth Steel.—It has been known that in the last years the American Rolling Mill Company, of Middletown, Ohio, has developed a process for making in the open hearth a very pure steel which they have placed on the market under the name of "American ingot iron" and for which the important claim is made that it resists corrosion successfully. Exact information on the process is now available from two patents recently granted to Mr. Robert B. Carnahan, Jr., the superintendent of the American Rolling Mill Company. The company is working under license from the International Metal Products Company, of Newark, N. J., to which both patents are assigned. One (940,785) is a product patent, the only claim referring to "improved rolling mill and bloomery ingots characterized by a deoxidized and degasified slagless body crystalline in structure and containing at least 99.80 per cent of iron, and containing not over 0.14 per cent of sulphur, phosphorus, carbon, manganese, and silicon taken in the aggregate, and containing not over 0.95 per cent of oxygen." The other patent (940,784) refers to the process of making this steel. A basic-open hearth furnace is charged with pig iron or cast iron or molten iron. In practice there has been substituted low-carbon iron or steel scrap to a considerable extent, in some cases as high as 80 per cent of the charge. Lime or limestone is charged to reduce sulphur and phosphorus, these agents being preferably charged prior to charging the metal. The charge is then refined, as in making soft steel, by the employment of ore or agitation, or both, but recarburization at this stage is not necessary in case the charge melts specially low in carbon. Carbon, manganese, sulphur, and phosphorus are thereby reduced. This refining operation is carried out for a much longer time, from one to four hours more, than is usually employed in making high-grade soft steel; naturally, while the carbon is being more and more reduced, the melting point of the iron bath rises and the temperature must be gradually raised, until it is finally at least 2850° Fahr. The refining operation is considered finished when by bath test the bath will contain not over 0.14 per cent of sulphur, phosphorus, carbon, manganese and silicon taken in the aggregate. For the best results it is desirable and practicable to reduce this aggregate to less than one-half the percentage named, and to have neither carbon nor manganese over 0.02 per cent.

The refined metal is poured into molds while still at high temperatures, and while still molten it is deoxidized and degasified to such extent that the resulting product will contain not over 0.05 per cent of oxygen as determined by the method of Ledebur, and preferably considerably below this, and will contain at least 99.80 per cent of iron. "The deoxidation and degasification may be very satisfactorily accomplished by the addition of aluminium in the molten metal, say, 2½ lb. per ton. If done in the furnace it is recommended that aluminium pig iron may be used." Aluminium may be economized by partially deoxidizing the bath by employing pig iron, say, 2 to 8 per cent of the charge. The degasifying and deoxidizing agents must, of course, not be such as to lessen the above-mentioned purity of the ultimate product. In tapping the metal the slag is floated off and the product is thus freed from it. We comment upon this very interesting process on our editorial pages. (940,784 and 940,785, Nov. 23, 1909.)

Annealing and Hardening Furnace.—Mr. W. S. Rockwell patents a furnace for annealing and hardening small pieces of steel, copper, brass, etc. Since the furnace has already been described in this journal, it should suffice to say that it is an internally fired cylindrical furnace, with a spiral lining, the furnace being rotated at a certain speed and charged and discharged automatically, a pyrometer indicating the actual temperature at the point of discharge. The only manual part of the operation is that of firing, but as the fuel is constant, and the temperature is indicated by the pyrometer, it is only necessary to get the speed of the furnace and the temperature correct before starting, after which the entire operation is automatic. The patent is assigned to the W. S. Rockwell Company. (940,280, Nov. 16, 1909.)

Mineral Wool.—In making mineral wool the molten slag or scoria as it comes from a cupola is blown by an air or steam blast into a blow tube and from there into a settling chamber. The commingling of the smoke and the hot filamentous slag acts to elongate and toughen the fibers of the mineral wool and completely convert the slag into filaments. In order to render the mineral wool waterproof and specially suitable for insulating boards and blocks, Mr. T. B. Parkinson introduces a heavy crude hydrocarbon oil (crude petroleum) in small streams or drops into the hot slag, as it comes from the cupola and before it enters the blow tube. The oil vaporizes, "the residue or smoke of the vaporized hydrocarbon being thus brought into intimate contact with the exterior surfaces of the flying filaments of molten slag and thoroughly coating the same." (945,583, Jan. 4, 1910. Assigned to Union Fiber Company.)

Roasting Furnace.—A novel construction of the rabbling mechanism for reverberatory roasting furnaces is the subject of a patent of Mr. Benjamin Hall. If the rabbling mechan-

ism travels from one end of the furnace to the other it often carries with it adhering unroasted ore. To avoid this, the present inventor makes the rabbles swing as a pendulum across the furnace. In order to push the material forward, the rabble shoes are tapered; the thicker end is toward the feed end of the furnace, so that the rabble shoes present a surface gently sliding down toward the discharge end, thus feeding the material along. (945,522, Jan. 4, 1910.)

Hot Blast Stove.—Since Dr. WALTER O. AMSLER'S new hot blast stove of the three-pass central-combustion-chamber type was described and illustrated in our December issue, 1909 (Vol. VII, p. 542) reference to the patent covering this construction must suffice here. (945,360, Jan. 4, 1910.)

Copper.

Smelting Sulphur Ores.—Mr. RICHARD FLEMING, of the General Electric Company, proposes to smelt sulphur ores, like copper ores of the pyritic variety, in the electric furnace as follows. The process is also suitable for smelting galena. It is carried out in a totally enclosed electric furnace. When the copper pyrite ore, which usually contains also iron pyrite and to which some silicious material is added as flux, is in a fused state, steam and air are blown up through it. The steam decomposes the melted sulphides and drives out the sulphur at the same time oxidizing the iron to form iron oxide, which combines with the silica to form silicates of iron. The copper settles at the bottom of the furnace as matte. The sulphur is given off as hydrogen sulphide, but at the high temperature of the electric furnace this is broken up into sulphur and hydrogen. If air is blown through the ore together with the steam, a certain amount of sulphur dioxide is formed, which yields the following two reactions:

$$SO_2 + 2H_2 = S + 2H_2O$$
$$SO_2 + 2H_2S = 3S + 2H_2O.$$

Hence the vapor is essentially a mixture of sulphur vapor and steam, together with the vapors of arsenic or zinc, etc., if these are associated with the copper. The vapor is condensed in a separate condenser. When a sufficient amount of copper matte has accumulated in the furnace it may either be run off to another furnace to be finally purified, or it may be separately blown with either steam, or with steam and air, in the same furnace. It is finally drawn off as metallic copper containing a small amount of impurities. (945,926, Jan. 11, 1910.)

Zinc.

Electric Zinc Smelting and Zinc Condenser.—In our Vol. VII, page 468, a full illustrated description was given of the electric zinc process of E. E. CÔTE and P. R. PIERRON, in operation in Southern France. A recent patent of the two inventors refers especially to the zinc condenser. This is a vertical cylinder with a lining of refractory earth and of greater diameter at its upper end than at its lower end. This condenser is kept at the proper temperature for zinc condensation by a vertical heating rod, in the center of the condenser. It is heated by an auxiliary electric current. It is a thin-walled tube of finely ground, strongly pressed refractory earth, filled with fragments of powder of retort carbon. The temperature in the condenser is adjusted by varying the length of this column of carbon, or by varying the size and state of comminution of these particles of carbon or by adjusting the current which passes through this column. There is only a comparatively narrow space between this vertical central core and the slightly inclined inside walls of the condenser and within this space the zinc vapor (which enters at the top) is condensed and the liquid zinc is drawn off from the inclined bottom. (944,774, Dec. 28, 1909.)

Zinc Oxide.—In a patent for a method of preparing zinc oxide for reduction Mr. H. PAPE emphasizes the disadvantages of the very loose condition of ordinary zinc oxide for reduction. He proposes to treat the zinc oxide in a muffle or reverberatory furnace, in which it is exposed for some considerable time, say, two to three hours, to great heat, which may advantageously exceed 1000° C. By this treatment the loose zinc oxide is condensed or solidified in such a manner that it coagulates into solid lumps and pieces, and this solidification can be carried to such an extent that the weight of a given volume of zinc oxide which has been thus treated and then reduced to pieces 3 mm in size is about five times as great as the weight of an equal volume of crude oxide, which is removed from the settling chambers or dust flues. When the zinc oxide has been coagulated and solidified by heat in the manner described it is withdrawn from the muffle or reverberatory furnace and allowed to cool. It can then be transported in the same way as roasted blende and after the larger lumps have been broken up it can be used in the same manner as blende for forming the mixture for reduction to zinc. The instability of zinc oxide, which is prejudicial in the reduction process, is entirely obviated by this means, as is also the coagulation of the oxide in the muffle during the reduction process. (947,399, Jan. 25, 1910.)

Zinc-Calcium.—The production of zinc-calcium and other similar alloys by melting together the two materials involves considerable loss. Messrs. G. O. SEWARD and F. VON KÜGELGEN propose to produce such alloys by the electrolysis of a mixture of salts of the two metals. For instance, for the production of zinc-calcium a mixture of calcium chloride and zinc chloride is used. However, the tendency of the current is to separate first only the zinc. To prevent this the zinc chloride is employed in a relatively small quantity. An electrolyte of fused calcium chloride is used, with a carbon or graphite anode, and an iron cathode of such dimensions relatively to the current used that the calcium is obtained in a molten condition. A current density of about 60 amp per square inch is suitable. Upon commencing the electrolysis a small proportion (from 1 to 5 per cent) of zinc chloride is introduced, and from time to time so much zinc chloride is added as is necessary to keep the concentration of zinc in the electrolyte constant. Calcium chloride is also fed to replace that decomposed, but the electrolyte is always kept so that the proportion between the zinc and the calcium salt remains constant or approximately so. The proportion of the zinc in the resultant alloy may be varied by adjusting the concentration of the zinc in the electrolyte. In similar manner may be produced alloys of calcium and aluminium, calcium and magnesium, barium and aluminium, barium and magnesium, etc. These alkali earth metal alloys are much more easily obtained than the alkali earth metals alone, for the reason that their melting points are lower and that there is not so much tendency for redissolution as with the alkali earth metals alone. (944,826, Dec. 28, 1909.)

Resistance Alloy—Mr. WILBUR B. DRIVER patents a resistance alloy of nickel and manganese in which the nickel predominates. Pure nickel has a comparatively low resistance, only about 12 microhms per cubic centimeter. A mixture of 95 per cent of nickel with 5 per cent of manganese gives a resistance of about 25 microhms per cubic centimeter, or twice that of pure nickel. Eighty per cent nickel with 20 per cent manganese gives a resistance of about 70 microhms; while 70 per cent nickel and 30 per cent manganese has a resistance of about 100 microhms. The melting point of these alloys is estimated to be in the neighborhood of 2500° Fahr. These alloys all have the advantage of not corroding readily on exposure to the air. They have the further advantage of electric stability, differing in this respect from alloys of copper and manganese alone. (943,066, Dec. 14, 1909.)

Calcium Carbide.

A number of patents have just been granted to Mr. HERMAN L. HARTENSTEIN, whose activity in the calcium carbide field has been repeatedly noticed in this journal.

Method of Manufacture.—The object of one of Mr. Hartenstein's patents is the use of anthracite coal screenings in the manufacture of carbide, while avoiding the disadvantages of excessive smoke generation in the furnace during reduction or the higher voltage required on account of the presence of particles of hard coal in the charge. The lime is taken from the calcining furnace while highly heated and is mixed with a

mixture of 80 or 90 per cent finely comminuted anthracite coal screening and 20 or 10 per cent of powdered coke (breeze) or charcoal. The result may be still further improved and facilitated by the addition to the carbonaceous constituent of from 3 to 20 per cent of bituminous coal rich in tarry compounds, say, about 5 per cent. It is this addition of coke and bituminous coal to the anthracite screenings which overcomes the above-mentioned difficulties. (946,511, Jan. 11, 1910.)

Attaining Uniform Composition.—To secure more uniform composition and quality, Mr. Hartenstein proposes to empty various charges of carbide as they are drawn from the furnaces into a large storage reservoir, allowing them to stand for some time before solidification in final form. During this storage period the different charges become thoroughly mixed merely by the dumping of each new charge, the heat being kept up by the constant accession of carbide direct from the furnaces at high temperature. This not only secures greater uniformity of composition, but allows for the perfect completion of all reactions. When a sufficient quantity of carbide has been collected part is drawn off. A certain amount, however, always remains in the reservoir The advantages claimed for the process over the mechanical admixture of the finished product is that the properties of all the granules are the same, thus obviating the possibility of troublesome secondary generations of gas. (946,510, Jan. 11, 1910.)

Carbide in Globular Form.—For use in acetylene generators of the "carbide feed" type, Mr. Hartenstein makes a carbide in globular form, by subdividing the solid carbide while still molten or plastic. This may be done, for instance, by a method analogous to that of making drop shot, the molten carbide being allowed to fall down a shaft under such thermal conditions that it preserves its fluidity sufficiently long to form spherical or rounded drops prior to solidification. Another method is to deposit molten carbide on a revolving table, from which it is thrown outward by centrifugal force in the form of globules. The globules are allowed to harden completely before packing. The main advantages of turning out the product in this form is that grinding is unnecessary and the fine dust, so troublesome on account of its excessive surface exposure to the atmosphere and its irregular generating qualities, is avoided. (946,433, Jan. 11, 1910.)

Carbide in Aggregated Mass.—In a process very similar to the above the globules are assembled after they have solidified enough to retain their shape, but before they have lost their surface viscosity. The particles thus become autogenously united to form an open-textured honeycombed mass. (946,497, Jan. 11, 1910.)

Utilization of Carbide Fines.—By incorporating finely powdered carbide as it comes from the crushing and sizing apparatus into the molten carbide coming from the furnace, Mr. Hartenstein produces a magma which solidifies without the usual piping and segregation, giving a fine grained homogeneous carbide block or body of uniform quality throughout and yielding but a relatively small proportion of fines on comminution. (946,432, Jan. 11, 1910.)

Electrode Holders.—Finally two patents of Mr. Hartenstein refer to mechanical details of carbon holders for use with electrodes in large furnaces. (946,434; 946,435, Jan. 11, 1910.)

Electrolysis of Common Salt.

Mercury-Cathode Diaphragm Cell.—The cell of Mr. J. J. Rink, of Copenhagen, Denmark, for the electrolytic production of caustic soda and chlorine from common salt is essentially a mercury-cathode cell, but the principal feature is that the mercury cathode is vertical. It consists of a vertical conduit plate, the pure mercury being supplied through a pipe on the top, and flowing downward on both sides of this conduit plate in a thin film. Anodes are placed on both sides opposite to this conduit plate, so that while the mercury film passes downwards, it is changed into a sodium or potassium amalgam. To prevent the chlorine, which is set free at the anodes, from coming into contact with the mercury or amalgam, diaphragms are inserted between anodes and cathode. The amalgam flows off at the bottom into a washing chamber, where the caustic is formed, the pure mercury being pumped up again to the top of the cell. (947,741, Jan. 25, 1910.)

Chlorate.—For the production of caustic soda and chlorine (bleaching powder) from common salt, it is all important to keep the anodic and cathodic products of electrolysis separate from each other, so much so that in the patent of the preceding abstract two means to accomplish this were provided; a diaphragm and the mercury cathode which absorbs the sodium ions and removes them from the field of electrolytic action. Just the reverse is true, if a common salt solution is electrolyzed to produce chlorate, as the chlorate formation depends on the interaction between the anodic and cathodic products of electrolysis. Messrs. Harry H. Bates and Folger Adams, of Joliet, Ill., feed the salt solution to be electrolyzed into a central compartment which is entirely separated from the anodic and cathodic portion of the cell. The central compartment is entirely jacketed by the hot solution in contact with the electrodes so that the liquid in this central compartment becomes heated. From this central compartment the hot sodium chloride solution is let to the outer portion of the cell which contains the movable electrodes. By this motion the electrolyte is kept in violent agitation and the chloride is changed into chlorate. From this compartment the liquid is drawn off into the ordinary cooling or settling chambers. (944,650, Dec. 28, 1909.)

Electric Discharges Through Gases.

Hydrocyanic Acid.—The classical examples of producing gas reactions by means of electric discharges are the production of ozone and nitric acid from air. Ozone is produced by the silent discharge through air; the oxygen is the only constituent of the air which is thereby affected; about the mechanism of the reaction we know little; it has even been suggested that the reaction is simply due to the ultra-violet light which accompanies the silent discharge. The production of nitric acid from air by the electric arc, on the other hand, seems to be, to a large extent at least, a thermal phenomenon; that is, the nitric acid would be formed from air if the latter was heated to arc temperature by other means. An interesting example of the possible extension of such methods is the production of hydrocyanic acid from nitrogen and hydrogen. It is known that by passing a mixture of nitrogen and hydrogen through an electric arc produced between two carbon electrodes, combination of the gases with the carbon volatilized in the arc to form hydrocyanic acid takes place. In practice when it is attempted to carry on this process on a large scale, it is found that in order to obtain any large quantity of hydrocyanic acid it is necessary to pass the gases at a comparatively slow rate through the arc, since if they are passed rapidly through it, they do not become sufficiently highly heated. Professor O. Dieffenbach and Mr. W. Moldenhauer, of Darmstadt, Germany, overcome this difficulty in an interestingly simple manner. The direct current arc is produced in a vertical furnace between a central carbon electrode at the top as cathode and a deep bed of unformed lumps of coke filling the lower part of the furnace as anode. In this way it is possible to produce a conical shape of arc playing between the carbon rod (which is only slowly consumed), and the lumps of coke below. The mixture of nitrogen and hydrogen gases is led upwards from the bottom of the furnace through the incandescent bed of coke and is thus preheated, before it gets into the zone of the arc proper. (941,768, Nov. 30, 1909.)

Generation and Storage of Ozone.—When the storage of ozone is accomplished by compression after generation the heat generated by the compression results in dissociating part of the formed ozone back into oxygen. To prevent this, Mr. Frank Ashley, of New York City, compresses the untreated air or oxygen, withdraws the heat generated thereby, and then allows the pressure to quickly drop a few pounds in the ozonizing

chamber, thereby expanding the oxygen and cooling it, and then subjecting it to the action of the silent electric discharge while under pressure. The ozone is then stored in a suitable storage reservoir without permitting it to expand much below the pressure under which it is generated. (942,046, Dec. 7, 1909.)

Ferro-Alloys.

Electric Furnace Construction.—Mr. E. F. PRICE of the Union Carbide Company and the Electro Metallurgical Company has formally proposed an electric furnace for the production of ferro-alloys, in which a considerable body of the charge, for instance a mixture of silica, iron ore and carbon for the production of ferrosilicon, is maintained around depending carbons of opposite polarity, thereby embedding the zone of reduction, retaining the heat within the furnace, increasing the production of metal, keeping the slag in a liquid condition, and protecting the electrodes from the oxidizing and cooling effect of the atmosphere. While the use of this deep charge-body is advantageous, it is found necessary in practice to employ a charge of coarsely granular materials, in order to permit the ready escape of the large volumes of gas which are evolved during reduction. A finely divided charge, however, could be preferable in many respects, enabling reduction to proceed more rapidly and smoothly, but when a deep body of finely divided material is maintained around the electrodes, the gases escape violently by blowing out portions of the hot unreduced charge and agitating the molten or semi-molten contents so as to short-circuit the electrodes. To prevent this disadvantage Mr. Price withdraws the waste gases laterally in different directions beneath the surface of the finely-divided charge. For this purpose an inclined shelf is employed inside the furnace and surrounding the electrodes above their lower ends. It is made of cast steel and is water-cooled. The charge drops from above, rests on this shelf and surrounds the electrodes, and passes downwards in the space between the rims of the shelf and the electrodes. In this way part of the space just below the shelf is kept free of the charge. Through this space, the waste gases are withdrawn. (942,349, Dec. 7, 1909.)

Furnace Construction.—Mr. Price also patents another method by which the gases and dust arising from the operation are continuously withdrawn without interference with the operation of charging the furnace or with the accessibility of the electrodes for adjustment or renewal. In this construction the furnace consists of an open vessel; opposite series of vertically disposed electrodes depend into the same and a stack is disposed upon the bath and between the electrodes whereby the air-current flowing to the stack passes around and between the electrodes. (942,350, Dec. 7, 1909.)

Ferro-Tungsten Furnace.—In electric furnaces, for the production of high-grade ferro tungsten, containing over 70 per cent, usually but a limited quantity of ore is treated in a single furnace-run; after reduction it is cooled in the furnace and subsequently removed by chiseling it out. Mr. CHARLES E. WILSON, of Hood River, Ore., proposes to use a furnace chamber in the form of a crucible with removable sides of refractory material and provided with a graphite bottom which forms one of the electrodes. Extending downward through the open top of the furnace is the other electrode in the form of a graphite pencil. The ore is fed into the furnace around the pencil. The slag making constituents of the ore form the heat generating material. As the reduction progresses the ferro tungsten agglomerates between the electrodes and settles upon the carbon-crucible, and as a core of the alloy builds up the crucible is lowered so as to gradually build up a ferro tungsten core enveloped in slag. When it has attained sufficient height the current is shut off, the contents of the crucible are allowed to cool, the removable walls of the furnace are taken off and the slag is easily broken off the ferro-tungsten core. (943,290, Dec. 14, 1909.)

Powdered Metallic Tungsten.—A process for the production of powdered metallic tungsten has been patented by Mr. WILHELM MAJERT, of Berlin, Germany. Finely powdered anhydrous sodium paratungstate is incorporated with lamp black in the proportion by weight of 500 to 35. This mixture is then agitated and heated in a reducing atmosphere. Metallic tungsten and sodium tungstate are formed and the latter is washed out, first by the use of slightly alkaline water, then of water aciduated with HCl or H_2SO_4, and then with pure water, until a neutral reaction occurs. The metallic tungsten residue is then washed with methyl or ethyl alcohol and then with benzol or with the lightest benzine, portions of which are allowed to remain incorporated with the residue, producing a plastic mass which may be left in tightly closed receptacles until it is desirable to utilize it. This prevents oxidation of the powder. The process is said to be specially useful for the manufacture of tungsten filaments for incandescent lamps. The same process is applicable with any hexavalent high-fusing-point metal. Suitable salts for the process are sodium paratungstate (Na_2WO_3) and sodium paramolybdate ($Na_2Mo_2O_7$) from which one molecule of tungsten or molybdenum may be reduced, leaving in the residue the neutral salts of sodium, tungstate (Na_2WO_4) or sodium molybdate (Na_2MoO_4). (946,551, Jan. 18, 1910.)

Miscellaneous.

Cleaning Process.—A very simple process for cleaning metal articles, especially silver, gold, etc., is as follows: The silver articles to be cleaned are placed in a tin-lined vessel (or an aluminium dish), filled with a hot alkaline solution. On account of the different position of silver and tin in the potential series, this represents a short-circuited galvanic couple, current flowing from the tin into the solution and then to the silver and back to the tin. The oxide film on the silver is thereby reduced to metallic silver by cathodic reduction, and the silver is cleaned. It is an electrolytic process without the use of any current from an external source. But the action soon ceases, because the tin becomes coated with a film which is difficult to remove, and which prevents effective electrical contact with the silver article. To provide such contact Messrs. James D. Phillips and Carl Hambuechen provide for the introduction of an auxiliary metal electronegative to the anode. Thus, if the anode is zinc, and it is maintained in electrical contact with the metal electronegative to it such as tin, silver, or solder, the latter metal will remain bright and may thus be used to secure an interrupted contact with the article being cleaned. For instance, to clean silverware, a vessel of tin or enameled ware may be used with a corrugated sheet of zinc lying loosely in the bottom. The upper portion of the ridges or corrugations are tinned or soldered, this tin or solder constituting the auxiliary metal and remaining bright, while making contact with the silverware placed in the vessel. The tarnished silver thus gets automatically cleaned. A suitable solution is prepared by dissolving one tablespoonful of baking soda and one-half tablespoonful of common salt in one quart of water. (945,865 and 945,866, Jan. 11, 1910.)

Carbon-Silicon Dynamo Brushes.—Carbons, when impregnated with a certain amount of silicon, are very hard and excellent means for polishing a commutator. The higher the silicon content, the greater the hardness and the less the conductivity. A patent of G. Egly (assigned to Gebr. Siemens) recommends to combine the carbon and silicon with nitrogen. The molded mixture of carbon and silicon is heated in a nitrogen atmosphere in order to produce a compound of nitrogen silicon and carbon. In this manner a very uniform binding of the entire mass and great homogeneity of the body is obtained. The kind of compound which is formed by nitrogen combining with silicon may be very different; when a sufficient quantity of silicon is employed and when the mixture is sufficiently heated apparently the chemical compound C_2Si_2N is formed. (942,379, Dec. 7, 1909.)

A Comparison of Welding Methods for the Repair of Castings.

In *Stahl und Eisen*, of Dec. 29, 1909, Director E. Lamberton, of Merzweiler (Alsace, Germany), gives an interesting comparison of different welding methods for the repair of gray iron castings in foundries, repair shops, etc. As the article is based on experience from German practice, we give it here in translation almost in full, but have added some notes on American practice. The methods discussed below may, of course, also be employed for welding steel, but cast-iron repairs are chiefly considered in the following article.

In every works it becomes necessary at times to repair broken castings. In foundries it is also occasionally necessary to attend to certain surface defects, flaws, etc., of castings.

All the welding processes to be described depend on simply fusing the parts to be welded together, without introducing any other material into the joint. While the different processes are more or less simple, all require certain precautions.

In the first place, any welding operation produces internal stresses or tensions within the portions which are being welded on account of the great internal temperature differences. With an unelastic material like cast iron this is a serious matter, since there cannot be any equalization of the stresses between the hottest parts and the colder adjoining parts, which often results in a new break. This can be remedied to a certain extent by careful preheating, and cooling as described below.

While no detailed rules can be formulated comprising all cases in practice concerning the method of preheating the pieces to be welded, yet one general principle should be observed. The conditions under which the welded piece is cooled after welding should be the exact reverse of the conditions under which it is preheated before welding and should be identical with the conditions under which it was cooled after the original casting operation was completed. It is, therefore, important to preheat the pieces (before welding) slowly and continuously up to the maximum temperature which can be reached by the available means. The pieces to be welded together should be held in a firmly fixed position during the welding operation, and preferably in such a way that the joint to be made is in a horizontal plane.

Another important point which needs attention is to keep the two surfaces to be welded free from rust and any impurity. If there is rust on one of the surfaces, then the iron oxide is decomposed by the fused iron, the oxygen of the iron oxide combining with the carbon in the fused iron; gas formation results and the weld is porous.

If the repair relates to the removal of blowholes or flaws, the unsound portion of the casting must be completely cut out. This is illustrated in Fig. 1, where *A* is the casting, showing the unsound portion; *B* shows to what depth it is necessary to drill a cavity, which is then to be filled up with fused iron. It is also advisable to make the surfaces of the cavity not smooth, but rather rough or corrugated to make it easier for the fused iron which is added, to stick to and unite with the surface.

Fig. 1.—Removal of blowholes or flaws.

The above principles hold good in general whatever the special method of welding. They should be followed carefully in any case.

Mr. Lamberton's comparison refers to the following methods: The old welding process by simply adding fused iron (so-called burning on); electric welding; thermit welding; "autogenous" welding (oxy-acetylene or oxy-hydrogen welding). (It is true that in speaking of "autogenous welding" the oxy-acetylene or oxy-hydrogen process is now generally meant; but this is really incorrect. "Autogenous welding" means strictly joining or welding without use of a solder which would introduce a foreign material into the weld. Every one of the methods mentioned above is really an autogenous welding method.)

Burning On.—This old process consists simply in surrounding the casting to be repaired with a mold of sand. A large quantity of liquid metal is then run past the surface to be welded until it reaches fusion heat. The excess of metal runs

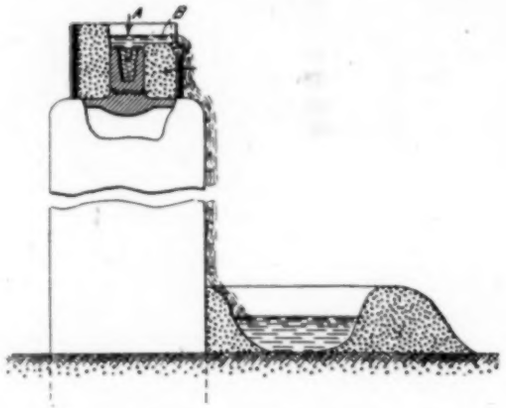


Fig. 2.—Repair of Fig. 1 by burning on.

off through an overflow channel which is preferably made of molding sand. Fig. 2 shows the repair of Fig. 1. The metal is poured at *A*. The outflow channel is at *B*.

Fig. 3 shows the repair of a machine frame, broken in operation. The arrangement of the mold is similar to the preceding case. The liquid metal is poured into *A*, and when it is seen to run off through *C* it is evident that fusion takes place at the desired depth; the channel *C* is then closed and further addition of fluid iron is stopped.

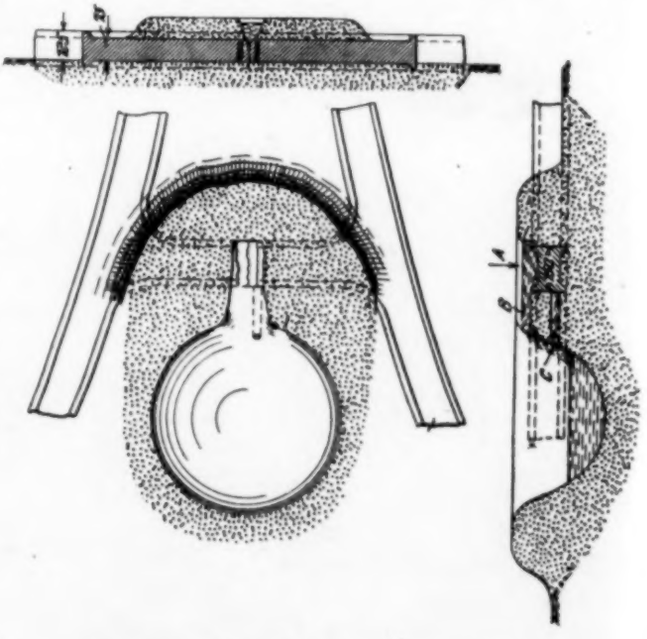


Fig. 3.—Repair of broken frame by burning on.

Fig. 4 shows the repair of a roll, to which a new boss is to be added. Some liquid iron is held for some time at *A* where the new journal piece is to be added, so that the contact surface is liquefied. The mold is completely filled with metal only after the weld has been produced in sufficient depth and after the overflow channel *B* has been closed.

With this process of welding by simple fusion it is important to arrange everything in such a way that the workingman who makes the repair can do it conveniently without being troubled by the heat of the iron running off through the overflow channel. The walls are covered with dry molding sand.

The molten iron which is added should have as high a temperature and fluidity as possible. The iron which is being added should come successively into contact with all points of the surface to be welded. This may be easily done with a

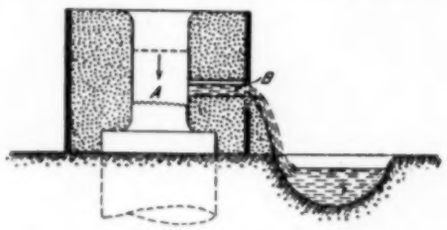


FIG. 4.—REPAIR OF ROLL BY BURNING ON.

hand ladle; but when large quantities of metal are needed and a crane must be used, it is difficult. It is necessary to make sure that fusion has been obtained at the desired depth; this may be done by inserting a perfectly clean and preheated iron rod.

After completion of the weld, the welded portion is covered with a layer of powdered charcoal and the whole is covered with dry sand to make sure that the cooling is slow.

The weld depends entirely on sufficient metal being run over the welding surface to bring it to fusion point. Then the flow is stopped and the metal retained in the mold will fuse with the casting. It is difficult to give general rules as to the quantity of liquid iron required; even to remove small surface defects 5 kg to 8 kg (11 lb. to 18 lb.) of metal are required to make success sure. For small repairs, like that of Fig. 3, 1 kg or 2 kg may be assumed per square centimeter (14 lb. to 28 lb. per square inch); for welding small axles or rolls 2 kg or 3 kg per square centimeter (28 lb. to 43 lb. per square inch). For large repairs these figures may be reduced one-half.

The above process can be used in any foundry, and is often employed with remarkable skill; but it must be remembered that

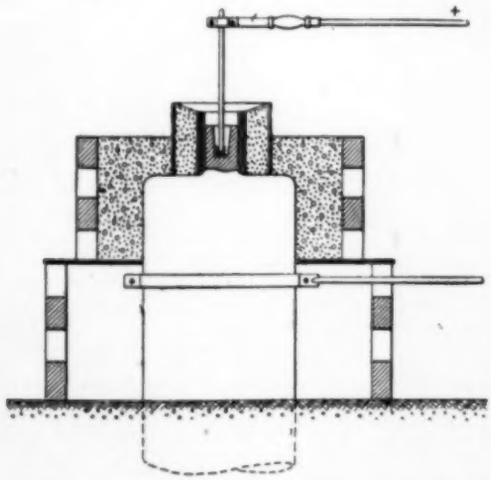


FIG. 5.—REPAIR OF FIG. 1 BY ELECTRIC WELDING.

the quantities of molten iron required for large repairs are considerable and that the handling of such large quantities is difficult and dangerous. (The old burning-on method is specially applicable for cast-iron repairs; for steel welding it offers greater difficulties.) The burning-on method is further restricted, however, to places where the necessary appliances are available, like foundries and machine works. Since this condition is often not fulfilled where a repair is to be made, the electric, thermit, oxy-acetylene, and oxy-hydrogen welding processes have been developed.

Electric Welding.—The chief disadvantage of electric welding is that it requires an electricity supply. Mr. Lamberton describes the Slavianoff process of electric welding, which is used in the works of Julius Pintsch, in Fuerstenwalde-on-the-Spree, in Germany. It is used there especially for the repair of broken locomotive cylinders, and is stated to give quite satisfactory results.

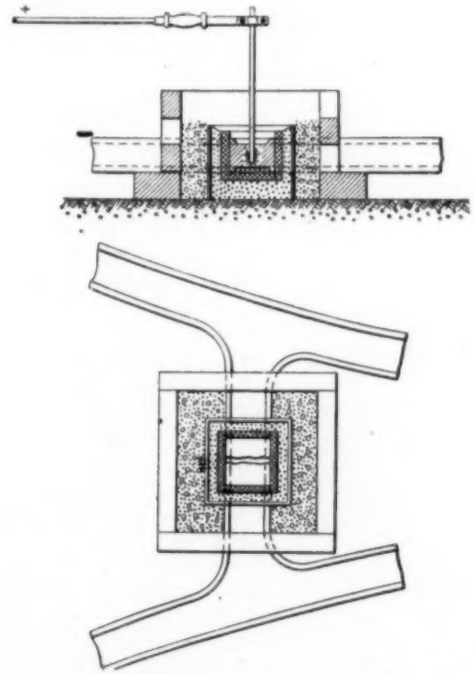


FIG. 6.—REPAIR OF BROKEN FRAME BY ELECTRIC WELDING.

An electric arc is formed between the piece to be welded and a rod of cast iron or steel (of the same composition as the piece to be welded). The method is clearly evident from Figs. 5, 6 and 7.

Fig. 5 corresponds to Fig. 3, showing the movable iron or steel rod which is connected to the positive pole of the circuit. It is 8 mm to 10 mm thick (5/16 in. to 13/32 in.). The piece to be

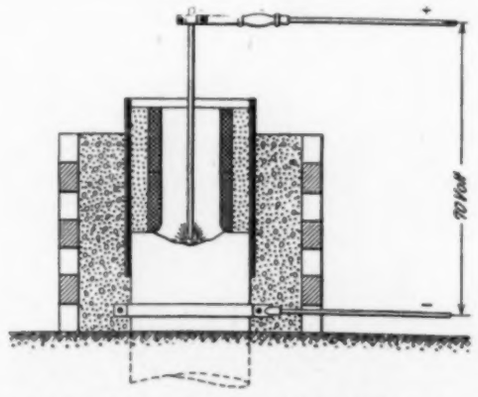


FIG. 7.—REPAIR OF ROLL BY ELECTRIC WELDING.

repaired is enclosed by pressed coke plates, surrounded by the molding sand in a sheet-iron box. The box is surrounded by charcoal or coke within walls of firebricks put together so as to leave open spaces. After the piece has been preheated by the charcoal or coke, the arc is produced by bringing the lower end of the iron rod in contact with the surface to be welded.

In Fig. 6, which corresponds to Fig. 4, it is necessary to enlarge the fracture so that the two surfaces to be welded are at a

distance of 20 mm to 30 mm (13/16 in. to 1 3/16 in.) from each other. The two surfaces are now heated to fusion temperature (beginning at the bottom), while fused iron drops off from the lower end of the rod *a* and unites with the metal of the two surfaces.

Since considerable heat is produced during the welding operation, it is possible to add cold iron in small particles. This is of special importance in Fig. 7 (corresponding to Fig. 5), where considerable quantities of iron are required to make the new boss. Of course, molten iron may also be added if it is available. Mr. Lamberton thinks a repair like that of Fig. 7 could not be well carried out by this process without the use of molten metal.

During the welding operation, especially when molten iron is added, it is important to keep the surface of the joint free from slag or other impurities to ensure a good union with the liquid metal. This is accomplished by repeated scraping off with an iron rod.

Direct current is used at 65 volts; the current is 400 amp to 600 amp according to the thickness of the iron rod *a*. The iron rod must be held during the welding operation so that the arc length is not more nor less than, say, 10 mm (25/64 in.). This requires skilled workmen. They hold the welding rod *a* by means of a pair of tongs, as shown in the illustration, and regulate the arc length by raising or lowering the rod.

Compared with the simple old fusion process of welding, the electric welding process gives a much stronger weld. This is probably due to the fact that no gases can form as the result of an oxidation process, so that the metal gets a very dense structure.

The above electric welding process has not been introduced into this country to our knowledge, although electric welding has been developed here to a large extent. It is used, however, in this country, not for making all kinds of repairs of castings, but rather in such cases where a manufacturer has thousands of

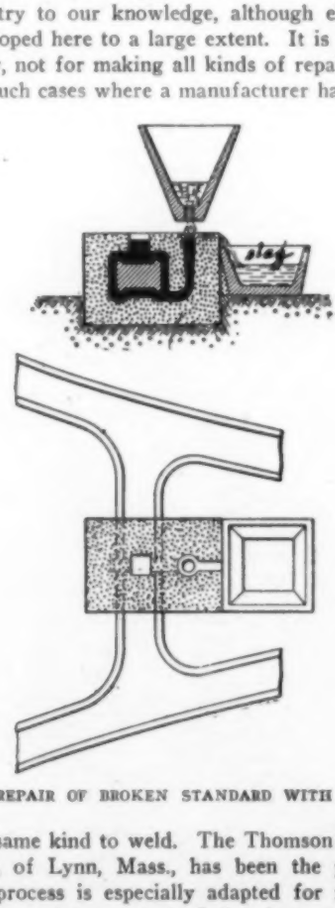


FIG. 8.—REPAIR OF BROKEN STANDARD WITH THERMIT.

pieces of the same kind to weld. The Thomson Electric Welding Company, of Lynn, Mass., has been the pioneer in this field. Their process is especially adapted for making a joint in solid sections, where an end of the piece, round or square, is abutted against the end of another piece of corresponding section; also for T-pieces, etc. Another development of their process is the welding of sheet-metal surfaces together in spots, or so-called "electric riveting." The process of the Thomson Electric Welding Company is also employed by the Electric Welding Company, of Pittsburgh. Other processes of electric welding are employed by the Toledo Electric Welding Company, Toledo, Ohio, and by the Standard Welding Company, of Cleveland, Ohio. But as this article is purposely restricted to a comparison of welding methods for the repair of castings, a discussion of the above electric welding methods is reserved for a special article in a future issue.

Thermit Welding.—The thermit welding process makes

$$Fe_2O_3 + Al_2 = Al_2O_3 + 2Fe$$

setting free a large amount of heat and producing very hot molten soft steel. The only requisites are thermit (a mixture of metallic aluminium and iron oxide), and besides this a small

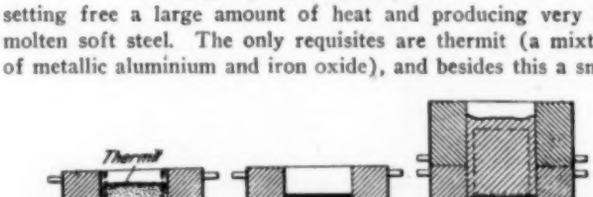


FIG. 9.—REPAIR OF ROLL WITH THERMIT.

amount of ignition powder, which, when lighted with a match, produces the required very high temperature to start the reaction. This process can, therefore, be carried out everywhere, since thermit can be easily transported, being neither explosive nor ignitible at any but very high temperatures.

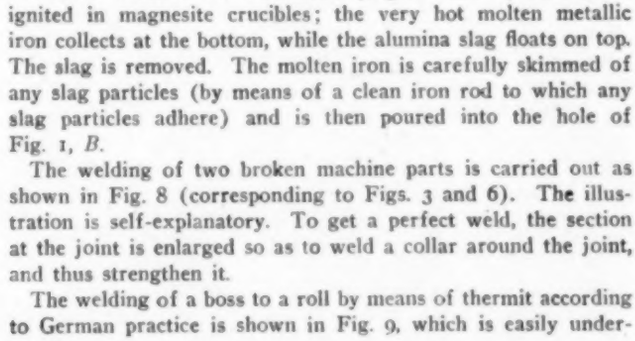
Since the thermit welding process, as carried out by the Goldschmidt Thermit Company, of New York, has been the subject of many articles in former volumes of this journal, no further description is here necessary. But it will be interesting to describe how, according to Mr. Lamberton, the typical repairs of Figs. 2, 3 and 4 are carried out with thermit.

For the removal of blowholes (Figs. 1 and 2) thermit is ignited in magnesite crucibles; the very hot molten metallic iron collects at the bottom, while the alumina slag floats on top. The slag is removed. The molten iron is carefully skimmed of any slag particles (by means of a clean iron rod to which any slag particles adhere) and is then poured into the hole of Fig. 1, *B*.

The welding of two broken machine parts is carried out as shown in Fig. 8 (corresponding to Figs. 3 and 6). The illustration is self-explanatory. To get a perfect weld, the section at the joint is enlarged so as to weld a collar around the joint, and thus strengthen it.

The welding of a boss to a roll by means of thermit according to German practice is shown in Fig. 9, which is easily understood.

It should be added that in the first two cases the joint is no



FIGS. 10 AND 11.—REPAIR OF ROLLS BY THERMIT.

longer cast iron, but thermit iron (soft steel). In special cases of cast-iron repairs this may be a disadvantage, but it is not necessarily so under ordinary conditions, so that Mr. Lamberton concludes that this particular point is not of importance.

Thermit is rarely used pure. Generally iron filings or steel scrap (about 5 per cent to 10 per cent) are added. These are thoroughly cleaned and are added to the crucible before the reaction is started.

With the thermit process it is also important to observe the same precautions of preheating and slowly cooling, described above. Large, solid pieces, which are liable to internal stresses on account of their form, must be preheated with special care. For this purpose a small transportable coke oven is often used abroad, while American practice prefers a gasoline torch operated with compressed air.

In other respects American practice does not differ from the above description of the operation of the thermit process with respect to the first two examples, namely, the removal of surface defects and the welding of two broken machine pieces. As to the third example, it may be said that the repair of broken rolls by thermit is used very extensively in this country, and the general practice is as follows:

In cases where a boss is entirely broken off the thermit process is simply used for the purpose of bringing the fractured surface of the roll to fusing heat, so that a new end may be burned on without difficulty. To accomplish this the roll is placed on the ground in a vertical position and a mold constructed of molding sand, thoroughly dried, is placed about the fractured end. This mold should be provided with an outlet or skim gate 8 in. above the fractured surface. Some steel works prefer to place this skim gate on a level with the fractured end, but it is better practice to locate it higher up. (Figs. 10 and 11.)

A quantity of thermit figured at the rate of 40 lb. to the square foot of surface to be welded is then placed in the mold and ignited. The heat of the reaction raises the temperature of the fractured surface to the fusing point and makes it possible to "burn-on" a section of metal to replace that broken off. This is accomplished by pouring in hot steel from the ladle suspended over the top of the mold as soon as the thermit reaction is completed. In the case of a cast-iron roll, molten iron is used instead of steel.

The pouring is continued until all traces of thermit steel and slag have been washed from the welding surface, when the outlet is plugged up and the mold filled to the top with metal. The waste used in washing off the surface is caught in a suitable receptacle and used to pour small castings.

After the weld has cooled it should be annealed by bringing the roll up to a temperature of 1200° Fahr. and holding it there for five or six hours, after which it is allowed to cool down slowly.

Rolls up to 44 in. in diameter have been successfully repaired in this way, and the process has also been used in welding on sections of steel to the shafts of large pinion gears. The cost of any of these operations, including thermit, labor, annealing and machine work, amounts to only a fraction of the cost of a new roll or shaft. The method of constructing the molds, as recommended by the Goldschmidt Thermit Company, of New York, is shown in Fig. 10 where *A* is the mold for boss, *B* the fractured end of the boss, and *C* the roll. A somewhat different arrangement, which is used by some American steel companies, is shown in Fig. 11.

Oxy-Acetylene and Oxy-Hydrogen Welding.—This method depends on the high temperature which is obtained in the oxy-hydrogen flame (about 4000 deg. Fahr.), and the even higher temperature obtained with the oxy-acetylene flame (about 6300 deg. Fahr.). The possibility of bringing the burner easily to the point to be welded, and, further, the fact that in repairing broken machine parts the welding operation proceeds gradually from point to point along the line or surface to be welded, are the main features of the process. The latter feature is of great importance, especially for repairs of curved surfaces, if pieces are broken out, as happens occasionally. A very interesting application of the process is the repair of broken gas-engine cylinders, which is difficult with other methods.

The repairs shown in Fig. 3 are made with the oxy-acetylene or the oxy-hydrogen flame by first chipping off pieces from both sides of the fracture so as to form a V-shaped opening. This is then heated and the V-shaped opening is filled carefully with uniform iron or steel particles. Then the welding with the oxy-acetylene or oxy-hydrogen flame begins, and care must be taken that the two surfaces of the solid pieces themselves become fluid, so that they combine firmly with the added material.

In cast-iron repairs a difficulty may be found in the affinity of cast iron for oxygen, so that the molten cast iron may get covered with an oxide film during the welding operation. Further, small globules may form at the joint and prevent the flowing together of the original surfaces with the added metal.

The easiest remedy in such cases is the use of one of the commercial fluxes, but not pure borax, since this may easily cause hardening of the joints.

To carry out such work requires a certain amount of skill and experience on the part of the operator. It is also of importance that the same material should be subjected only once to the welding process, since otherwise it may get hard and brittle. As to the material to be added for making the weld, a soft charcoal iron, low in carbon and as free from sulphur as possible, may be used.

The cost of the process is exceedingly low, but depends in such a degree on the greater or smaller skill and experience of the workman that reliable figures cannot be given. The main item of cost is doubtless the cost of preheating the piece to be welded. The other repairs described above may be made in an analogous way.

Like the thermit process, which has made rapid progress during the last five years in this country, the oxy-acetylene process has also made remarkable advances in the United States, especially during the past few years. There are quite a number of different companies interested in this process. The chief differences between the various processes occur in the types of burner employed, the types of acetylene generators used, and the method of producing oxygen..

Among the companies making oxy-acetylene apparatus in this country are the American Oxygen Company, of Philadelphia (formerly the American Ferrofix Brazing Company), the Beltzer-Delcampe Welding Company, of Bridgeport, Conn.; the Davis-Bournonville Company, of New York City; the Industrial Oxygen Company, of New York City; the Linde Air Products Company, of Buffalo, N. Y.; and the Worcester Pressed Steel Company, of Worcester, Mass.

These companies use differently designed blowpipes, the chief point of the design always being the provision of means by which both a perfect control of the flame and a thorough mixture of the two gases in easily adjustable proportions are realized. (The properly adjusted oxy-acetylene welding flame is neutral in character; *i.e.*, neither oxidizing nor reducing, except in very special circumstances with special alloy steels. The final regulation of an oxy-acetylene flame is always made by its appearance, gage adjustment being merely an approximation.) It is customary to make a distinction between low-pressure and high-pressure blowpipes, according to the pressure at which the acetylene is supplied to the burner. Both systems have certain advantages. A typical example of a high-pressure torch is that of the Davis-Bournonville Company, while low-pressure torches are those of the Industrial Oxygen Company, Linde Air Products Company and American Oxygen Company. However, a description and discussion of the different torches is reserved for a special article in a future issue.

As to the generation of acetylene, there are also quite a number of generators on the market, all based, of course, on the reaction between calcium carbide and water. A distinction may be made between water-fed and carbide-fed generators, according to whether water is fed into carbide or carbide into water.

An even greater variety exists in the methods of producing oxygen employed by the different companies.

The Davis-Bournonville Company, of New York City, use the chloride of potash process. A mixture of chloride of po-

tassium and manganese dioxide is placed in a retort and heat is applied. Thereupon the oxygen gas is given off.

The Industrial Oxygen Company, of New York City, employs an electrolytic product called "oxygenite," in the form of a gray pulverulent mass, resembling fine sand, releasing, when incinerated in a closed vessel, all the oxygen it contains, amounting to about 5¼ cu. ft. per pound, burning slowly and without flame.

The H. W. Dopp Company, of Buffalo, N. Y., use lavoisite, which is a dry and non-combustible powder made by the Castner-Electrolytic Alkali Company, of Niagara Falls. Water is added to lavoisite, thus causing an evolution of oxygen gas, 1 cu. ft. of oxygen per pound of lavoisite.

The Roessler & Hasslacher Chemical Company, of New York City, make a compound called oxone (fused sodium peroxide), which in contact with water produces very pure oxygen.

The Worcester Pressed Steel Company now get their oxygen compressed in cylinders, but formerly used the epurite process, epurite being a mixture of chloride of lime, sulphate of copper and sulphate of iron. Oxygen was produced by the contact of this material with water.

The Beltzer-Delcampe Welding Company use a compound called oxyvite.

The American Oxygen Company make their oxygen by a secret process.

While all the above methods make use of chemical reactions for the production of oxygen, an entirely different process is used by the Linde Air Products Company, which gets the oxygen gas from atmospheric air by liquefying the air and by fractional evaporation of the liquid air, thus separating the oxygen from the nitrogen.

Finally, oxygen is made by electrolysis of the water by the American Oxhydric Company, of Milwaukee. This is the only American company using the oxy-hydrogen instead of the oxy-acetylene welding process on a large scale and making oxy-hydrogen welding appliances. This concern compresses oxygen and hydrogen to tanks and supplies the gases in this form to their customers.

An oxy-hydrogen burner made by the Buffalo Dental Manufacturing Company, of Buffalo, is for use by lead burners for constructing and repairing all kinds of lead work, but this blowpipe is not suited to the brazing of iron and steel.

As noted above, a more detailed description of the different oxy-acetylene and oxy-hydrogen methods of welding is reserved for a future article.

Comparison of Different Welding Methods.—In summing up his discussion of the use of the different welding methods for the repair of gray iron castings, Mr. Lamberton reaches the following conclusions.

In foundries he pleads that the old burning-on process should not be superseded entirely by the new methods; the first consideration should always be whether the old process can be used. If a repair is unsuccessful, it would not be right to blame the burning-on process itself, since one cannot be sure that the repair would have been successful if carried out by another method. The new methods also require quite a good amount of skill and car (and we would add that the skill required for oxy-acetylene, oxy-hydrogen and electric welding is the skill of the mechanic, while the skill required for thermit welding is the skill of the foundryman).

Mr. Lamberton thinks that for repairs of gray iron castings the old burning-on process has the advantage of a lower temperature; the internal stresses have a much better opportunity to equalize, while the piece to be welded is better preheated by the use of the very large quantities of molten iron.

Nevertheless, foundries should make use of the new methods where they offer advantages. For small and special repairs, Mr. Lamberton thinks that the oxy-acetylene or oxy-hydrogen flame is advisable, although, partly at least, they may also be made by electric welding. Repairs of medium size he recommends to make by the old burning-on method. For large repairs a combination of the old burning-on process and the thermit process is the only feasible method; the thermit is then used for the purpose of preparing and liquefying the solid surface, while the fused cast iron which is added produces the final union (being of the same composition as the piece to be welded).

Outside of foundries and repair shops, of course, the old burning-on method cannot be used, because the appliances are not available. For emergency repairs on docks, on board ship, in mines, etc., one of the newer methods must be employed. Mr. Lamberton then recommends the making of small repairs by oxy-acetylene or oxy-hydrogen welding, and the making of medium and large repairs by the thermit process.

Mr. Lamberton finally remarks that the equipment for oxy-acetylene or oxy-hydrogen welding is cheap enough while the thermit process requires no equipment at all besides the crucible and thermit. The electric process requires electric power, and cannot, therefore, be used everywhere. But the process yields an especially strong weld, and managers of those plants which have electric current available should acquaint themselves with this method. In conclusion, Mr. Lamberton says that the cost of the heat is approximately the same in the different processes, so that the choice of one of them should be based on the conditions of each case.

Wisconsin Research Fellowship.—Two engineering fellowships, each worth $400 a year, have been established by the regents of the University of Wisconsin. These are in addition to three graduate scholarships already offered in the College of Engineering, and will give still further impetus to the research work at that institution. This year thirty graduate students are doing advanced work in the research laboratories in the testing of materials, particularly of reinforced concrete; hydraulic problems; electrochemistry and chemical engineering. Some of the results of these researches have been published in seven bulletins of the university engineering series.

Refractories in Furnace Construction.

In the excellent little treatise recently issued by the Harbison-Walker Refractories Company, of Pittsburgh, Pa., on the open-hearth furnace and process, a concise summary is given on the principal refractories used, especially in **open-hearth bottoms,** both in the acid and the basic process. The summary, however, is of much broader interest, and in view of the prominent position of the Harbison-Walker Refractories Company in the manufacture of refractories for general and special purposes, these notes are here reproduced in full.

Acid Materials.

The only acid material used is **silica** sand, all acid furnace bottoms being made from it. A natural sand is often used containing various percentages of silica, a typical analysis being, for instance:

Water	0.24 per cent.
Silica	97.25 " "
Alumina and iron oxide	0.16 " "
Lime	0.08 " "
Magnesia	0.39 " "
Alkalies	0.36 " "
Loss on ignition	0.36 " "

Certain beach sands give very good results, and there are also a number of deposits in the West and Middle West, but it is impossible to predict by analysis alone the quality of a given sand. If of excessive purity there is difficulty in properly setting it in the furnace, and if the impurities run too high, although the sand will then easily frit or set, it is subject to great erosion in the operation of the furnace and will not make a sufficiently hard, dense bottom.

The physical characteristics have a wide bearing on the question of its adaptability, and two sands of practically identical analysis may considerably differ as to their suitability for bot-

tom work. Often a combination of two or more sands will secure the best results.

Neutral Materials.

Carbon, while almost perfectly resisting the action of the slag, is very rapidly destroyed on account of the great affinity of the metal for it. It has often been tried in the form of brick, as well as rammed with tar, and, although the matter is again and again reviewed by those not familiar with previous experiments, its practical use is out of the question for open-hearth bottoms. (As to the use of carbon, carborundum and silico-carbides as refractories for electric furnace construction, see, for instance, the article by F. A. J. FitzGerald, our Vol. II, page 441.)

Bauxite, a hydrous oxide of alumina, analyzing approximately:

Silica, SiO_2	4 to 7 per cent.
Iron peroxide, Fe_2O_3	3 to 5 " "
Alumina, Al_2O_3	60 " "
Water, H_2O	30 " "

although exceedingly refractory, is subject to excessive shrinkage at furnace temperatures. It is very difficult to so calcine as to entirely eliminate this shrinkage, and when so calcined all plasticity is lost through loss of its combined water. In modern open-hearth practice it is never used.

Chromite, a sesqui-oxide of chromium, usually termed chrome ore, which has been rather more thoroughly tried out abroad than in this country, is extremely infusible and practically neutral, but its infusibility renders it very difficult to set or sinter thoroughly, and is has been found practically impossible to so thoroughly set the bottom that it will not be subject to mechanical erosion rather than any chemical reaction. It will analyze as follows:

Sesqui-oxide of chromium, Cr_2O_3	38 to 40 per cent.
Alumina, Al_2O_3	24.5 " "
Iron peroxide, Fe_2O_3	17.5 " "
Silica, SiO_2	3.25 " "
Magnesia, MgO	15 " "

In spite of its high refractoriness it has, when selected with due regard to its analysis, and when properly prepared, a large and rapidly widening field in daubing and patching around the slag line, back walls, ports, jambs, etc.

Of course, a neutral bottom would be the ideal one for open-hearth practice, inasmuch as any change from the basic to acid process, or *vice versa*, could be made without change in the furnace, but as indicated above, the materials at our disposition do not allow a satisfactory neutral working bottom.

Basic Materials.

Lime, or calcium carbonate, $CaCo_3$, is, in its calcined form, CaO, theoretically an excellent material for bottoms, but it is practically out of the question due to the rapidity with which it slakes when exposed to air. When reheated, the rapid driving off of the gas and water reduces the lime to a powder, in which condition it is rapidly worn away.

Dolomite, a magnesian limestone, is one of the materials very commonly used for patching bottom, and in some cases even for the entire bottom particularly by those to whom its comparatively low first cost appeals, but it is open to the same objection as lime, only in a lesser degree, *i.e.*, slaking on exposure to the atmosphere, and if a stock is more than 10 days or two weeks old this becomes an important factor. Of course, when the plant calcines its own dolomite this is a less important consideration. Furthermore, it is impossible to so set a dolomite bottom that it shall be as dense and vitreous as magnesite, and in spite of most watchful care portions of the bottom will from time to time become detached and float. In a dolomite bottom where, through erosion or absorption of metal, a hole or depression is once started, disintegration progresses with much more rapidity than with magnesite, and there is considerably more liability of serious breakouts. A fairly representative analysis of dolomite is as follows:

Silica	5.52 per cent.
Alumina and iron	3.74 " "
Calcium	29.20 " "
Magnesia	17.31 " "
Loss on ignition	43.82 " "

In a number of instances the absorption of the impurities from the dolomite has proved an exceedingly serious matter in the manufacture of high-grade steels and has resulted in an increased use of magnesite. Dolomite sets somewhat more rapidly than magnesite.

Magnesium carbonate ($MgCo_3$), when calcined to the oxide MgO, commercially known as magnesite, is unquestionably the best material for open-hearth bottoms, and all original bottoms are now installed with it. Even by those using a large percentage of dolomite in repairing it is admitted to be the best material available, absolutely the only argument in favor of dolomite being its low first cost. The well-known Austrian magnesite of the following approximate analysis

Silica, SiO_2	2.84 per cent.
Alumina, Al_2O_3	0.929 " "
Iron peroxide, Fe_2O_3	8.571 " "
Lime, CaO	1.120 " "
Magnesia, MgO	85.32 " "
Carbon dioxide, CO_2	0.50 " "

gives such a proportion of iron, etc., as makes the material set in the furnace bottom, forming a hearth of maximum density, subject to minimum erosion by the metal and practically unaffected by the slags. Furthermore, on indefinite exposure to the atmosphere almost no deterioration takes place, while with a dolomite bottom under like conditions, should furnace shutdown occur, the bottom would of necessity be renewed. The large deposits of Austrian magnesite insure ample supply for years to come.

Grecian magnesite has been used as a bottom material, but on account of its high refractoriness there is difficulty in fusing it in place, it being necessary to introduce impurities in the way of silica, clay, or oxide or iron in amounts sufficient to reduce its refractoriness. The resultant is too variable a quantity to give reliable results, and Grecian magnesite is very seldom employed.

A Novel Type of Dryer.

In view of the interest shown in the articles on drying in recent issues of this paper, and in view of the great importance of this class of apparatus in many metallurgical and chemical processes, the following brief notes on a recently perfected dryer which operates on a somewhat novel priciple should prove interesting.

The fundamental idea of this dryer, built by the Atlas Dryer Company, of Cleveland, is that of bringing into direct contact with the material to be dried a greater quantity of heated air than is possible with the usual form of cylindrical rotary dryer.

The manner in which this is done is clearly shown in Figs. 1 and 2. From the basic idea of drawing the heated gases through a screen and through the material to be dried was evolved the sectional cylinder, Fig. 1, so designed that the hot gases and air can be drawn through the periphery and into direct contact with the material, the latter being kept constantly "cascading" by the vanes or lifting blades, shown in Fig. 2, as the cylinder rotates in a clockwise direction when viewed from the furnace end. The inclination of the cylinder, of course, keeps the material moving longitudinally.

The cylinder, as will be seen from the illustrations, consists of six curved sections held together by six channel irons running the entire length of the sections. In the channels are slotted openings for the admisison of the heated air and gases. By reference to Fig. 2 it will be seen that there are six broad curved lifting blades directly opposite and inside the openings in the channel irons; these perform the dual duty of guarding

the air passages, thus preventing the drying material from falling out, and of lifting and cascading the material. The broad blades are assisted in the latter function by the small lifting blades.

A casual consideration of such a cylinder with peripheral openings of considerable size is apt to lead to the impression

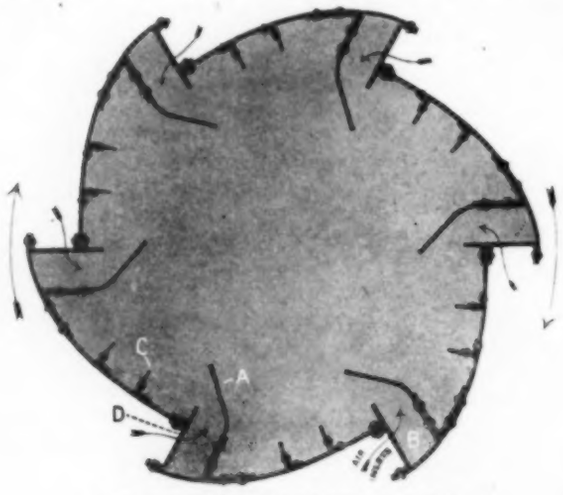


FIG. 1.—SECTION OF DRYING CYLINDER.

that the material within the cylinder will, in operation, fall through the openings. A study of Fig. 2, either imagining it to rotate or actually rotating it in a clockwise direction, will show how this is impossible. Take the air inlets at the bottom and right of the view; they are cut in a surface which is in a radial plane; as it rotates under and to the left, material from the blades already up on the ascending side does not commence to fall into the "pocket" formed between the blade and the channel iron until the radial plane of the web of the channel is well past the vertical and the openings, consequently, at the upper side of the "pocket." Material from the small lifting blades does not fall into the larger until that plane is almost horizontal, hence none of the material can leave the cylinder.

In the equipment shown in Fig. 3 the furnace is coal-burning, with a mechanical stoker *F* driven from the rotating mechanism. This stoker is furnished with the dryer. By making changes in the furnace gas any other fuel may be used.

In the comparatively short time that these dryers have been on the market they have been operated with a great degree of success in gunpowder plants, cement works and for glass manufacturing and paving work, where they handle large quantities of sand, gravel, etc., up to 200 tons per 10-hour day. Chemicals which will stand a moderate degree of heat, and, in fact, nearly everything which can be dried without vacuum is suitable "feed" for this dryer.

The method of installation of the dryer is shown in Fig. 3. The cylinder is surrounded by a steel casing, into which pass the heated air and gases from the furnace. An exhaust fan *E* draws the heated air through the openings into the cylinder, through the falling material within, and out at the exhaust. Set along the base of the casing are doors *G*, which may be opened if desired to reduce the temperature of the air and gases from the furnace before their delivery into the cylinder. The relief stack shown in Fig. 3 is used in starting the fire—if solid fuel is used—to carry off the smoke until the furnace is hot, and when the dryer is shut down.

In the instance of a large provision and packing company this dryer replaced another modern type with a resulting increased capacity of more than 140 per cent. Sixteen pounds of water were evaporated per pound of combustible consumed on the stoker bars, and tankage, blood and bones were dried without deterioration, without blowing out dust and without danger of fire, as stated by Mr. W. M. Cummer, of the Atlas Dryer Company, Cleveland, Ohio, to whom we are obliged for much of the information in this article.

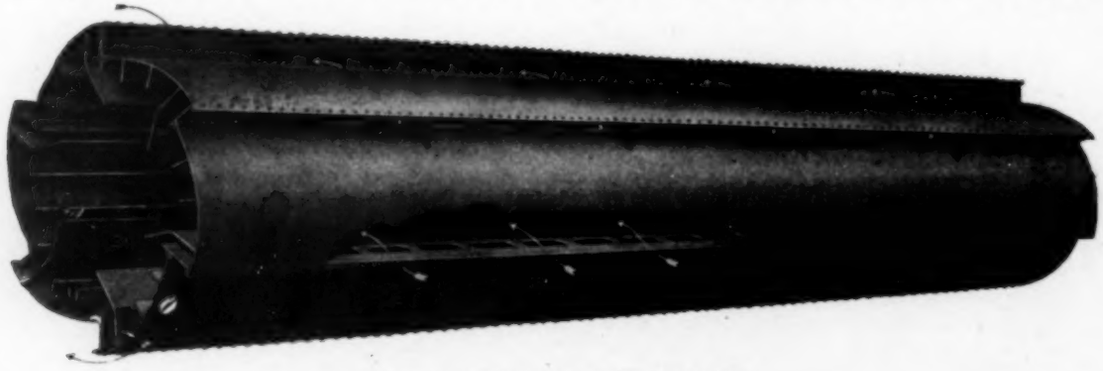


FIG. 2.—PERSPECTIVE OF DRYING CYLINDER.

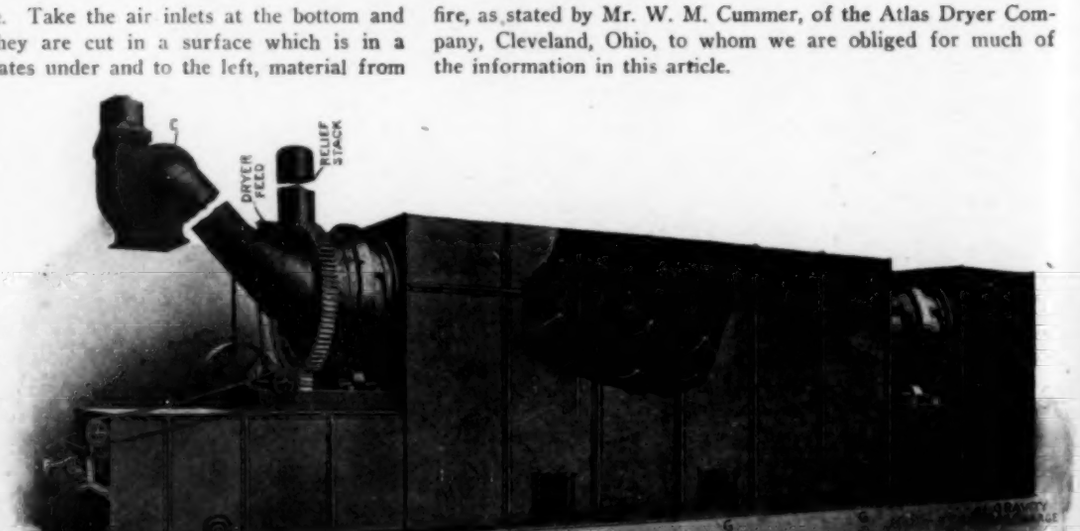


FIG. 3.—DRYER COMPLETE.

In this dryer the hottest gases are brought in contact with the wettest material, which is fed in at the furnace end. The further the gases go from the furnace, the cooler they become and the drier also is the material with which they come into contact. The location of the exhaust blower at the front end gives the strong suction where the material is wet and heavy, and permits of a gradual reduction of pressure to practically zero at the discharge end, where the dried material is light.

Successful practical operation has demonstrated that material does not leak out of the cylinder nor is it drawn out as dust in the exhaust.

Production of French Bauxite.

The composition and properties of red French bauxite were described in our November issue (Vol. VII, page 497). During the last three years there has been shipped by the French company handling the product, an average of 46,000 tons of bauxite per year. In the two years preceding this period the shipments only reached 32,000 tons per year. Orders have been received calling for the shipment of 60,000 tons during 1910.

Not only has the amount of bauxite mined during the past five years equaled the tonnage shipped, but it has exceeded it, and the owners now have on hand, either in warehouses or at the mines, a ready stock of 400,000 tons.

The Continental-American Ore Company, of 33 Broad Street, Boston, Mass., are the American agents for this bauxite.

Notes.

Electric Steel Plant.—While the 15-ton Heroult electric furnace of the U. S. Steel Corporation at South Chicago has been in continuous operation since last summer, the second Heroult furnace of the same capacity at the Worcester works has been started in aJnuary, and is reported to work very satisfactorily. While at South Chicago the electric furnace is used for refining molton bessemer steel, open-hearth steel is electrically refined at the Worcester plant. The product is used chiefly for steel wire.

Contract for Girod Furnace.—C. W. Leavitt & Company announce that they have closed their second American contract for the installation of a Girod electric steel refining furnace.

Proposed Chemische Reichsanstalt.—Considerable interest has been created in the German chemical world by the decision to form an Imperial Chemical Institute. This institution is to undertake for the chemical industry similar functions to those which the Imperial Physical Institute performs for engineering. The undertaking is being subsidized by the State, and it is expected that the annual maintenance will cost about $10,000.

Cornell University is giving a course of lectures on industrial chemistry by practising chemical engineers. As part of this course Dr. John E. Teeple, of New York City, recently delivered five lectures on the manufacture of sulphuric acid.

Engineers' Society of Western Pennsylvania.—The thirtieth annual meeting of the Engineers' Society of Western Pennsylvania was held in the rooms of the organization, Pittsburgh, Jan. 18, Mr. E. K. Morse, who succeeded to the presidency on the death of George T. Barnsley in October, presiding. The annual report of the board of directors, including the reports of committees, sections and the treasurer was read, indicating the general prosperity of the society during the past year. The membership of the society at the close of the year was 835. The following officers were elected for the ensuing year: President, E. K. Morse; vice-president, J. O. Handy; treasurer, A. E. Frost; directors, A. R. Raymer, Willis Whited.

Western Society of Engineers.—As the result of a letter ballot the Western Society of Engineers has elected the following officers: President, John W. Alvord; first vice-president, O. P. Chamberlain; second vice-president, A. Bement; third vice-president, W. K. Hatt; treasurer, Albert Reichmann. W. W. Curtis is elected a new member of the board of trustees, and the retiring president, Andrews Allen, becomes an ex-officio member of the board of direction.

Mining Institute of Scranton.—This organization ended its year on the evening of December 23 by holding its annual banquet at Scranton, Pa., with a large attendance. Superintendent Phillips, of the Lackawanna Railroad, Superintendent Jennings of the Pennsylvania Coal Company, Prof. A. H. Welles, and Superintendent William H. Allen, of the Scranton Coal Company, were the speakers.

Canadian Mining Institute.—The twelfth annual general meeting of the Institute will be held in the city of Toronto, March 2, 3 and 4. The headquarters will be at the King Edward Hotel. Among those who are expected to prepare papers are: H. F. Bain, Dr. A. E. Barlow, P. McN. Bennie, William Brewer, R. W. Brock, H. P. H. Brumell, Colin St. G. Campnell, Thomas Cantley, Fritz Cirkel, J. M. Clark, Eugene Coste, Dr. James Douglas, John A. Dresser, F. W. Gray, Allan Greenwall, R. E. Hore, Frederic Keffer, J. D. Kendall, Thomas Kiddie, Frank E. Lathe, B. B. Lawrence, R. H. Richards, Dr. Heinrich Ries, Edgar Slansfield, W. J. Woolsey and H. H. Yuill. H. Mortimer Lamb, Windsor Hotel, Montreal, Quebec, is the secretary of the Institute.

Examinations in Chemical Technology.—The Council of the Institute of Chemistry of Great Britain and Ireland will arrange to hold examinations in chemical technology in April. The examinations will be open only to Fellows and to those associates who have been registered as such for at least one year who produce evidence of practical technological training.

The Chemical Society of London, in honor of the completion of fifty years' fellowship by their past presidents, Sir Henry Roscoe, Sir William Crookes, Dr. Hugo Müller and Dr. A. Vernon Harcourt, will entertain them at a dinner of the society to be given some time near the end of May or the beginning of June.

New South African Engineering Institution.—The first annual meeting of the South African Institute of Electrical Engineers was held recently under the chairmanship of Mr. J. R. Bradley. Applications for membership were received from 158 persons, of which 71 have been elected members, 65 associate members, 14 associates and 8 students. Mr. C. M. R. Campbell was elected president, and Mr. W. Eldson-Dew and Mr. M. Rohman were elected vice-presidents.

The French Academie des Sciences have awarded the Hébert prize to M. Paul Janet for his work on alternating currents covered in the new edition of his "Leçons d'Electricité," the Hughes prize to M. Meslin for his work in optics and allied fields, and the Gaston Planté prize to M. Jean Perrin for his work on cathode rays.

Electric Process Quartz Vessels.—A company with a stock capital of 200,000 marks has been organized for the erection of works at Biebrich am Rhein to manufacture quartz vessels (fused silica) by the electric furnace process.

The Hardinge Conical Mill Company of New York City has established a tentative branch office at 415 Bailey Building, Seattle, Wash. Mr. V. G. Lunt, former secretary to Mr. Hardinge, is in charge of this branch, which will operate as a special sales office.

Hoisting Apparatus.—The Brown Hoisting Machinery Company, of Cleveland, Ohio, issues a full library of catalogs covering the different forms of machinery made by them. In the list are catalogs dealing with crabs and winches, blast furnace-hoists and stock distributors, buckets and tubs, locomotive-coaling stations, sewer and trench machines, locomotive ore-handling cranes, coal and coke-handling machinery, all-steel window sashes, and "Ferroinclave." This latter is a corrugated roofing which is erected on steel supports and then covered with cement. The circular illustrates several novel uses to which the product may be put, such as the construction of stairs, side-walls, highway bridges, culverts, water tanks, stacks and coal bins. We will deal with some particularly interesting subjects found in these catalogs in a future issue.

Export Office Opened.—The General Fireproofing Company, of Youngstown, Ohio, has opened an export office at 396 Broadway, New York City, in charge of Mr. A. D. Level, who has been for several years with the United States Steel Products Export Company.

The Société électro-métallurgique piémontaise at Ixelles has organized a new company to take up the handling of auriferous ores by the *Froment* process. The capitalization has been set at 2,500,000 francs.

Cyanide Plant Opens.—The old mill of the Natividad y Anexas Mining Company in the Sierra Juarez district, State of Oaxaca, Mexico, has been closed down and the ores will be treated by the new cyanide plant, which has just been finished.

Bonus for Ethyl Alcohol Plant.—The citizens of Parry Sound, Ontario, have voted a by-law to loan $30,000 to the Union Iron Works for the establishment of an iron-working plant, and also a $10,000 bonus for the erection of an ethyl alcohol plant.

A large Carbide works will be erected in Darfe in Camonicatal by the Aktien-Gesellschaft Ferriere di Voltri. The factory is situated favorably in a very good limestone district which is also rich in water-power.

New Factories.—Carl Zeiss and Company are building a large factory at 29 Margaret Street, London, E. C. The London chemical firm of Allen & Hanbury, Limited, is erecting an extensive plant at Hull.

Passaic Steel to Operate Again.—The property of the Passaic Steel Company, sold recently under the direction of the Chancery Court, has been taken over by a corporation composed of members of the bondholders' committee, and will be operated under the name of the Passaic Structural Steel Company. The new corporation paid $400,000 for the plant and $80,000 to the city of Paterson, N. J., for back taxes. The works were sold by the Passaic Rolling Mill Company to the Passaic Steel Company a few years ago for $1,800,000.

Aluminium.—The British Aluminium Company of 109 Queen Victoria Street, London, has issued a folder giving full particulars, resistance weights, and the like, of standard aluminium conductors ranging in size from 0.000924 sq. in. to 1.0606 sq. in. in cross-section, in comparison with the most nearly equivalent sizes of copper conductors. This comparison serves to show that the aluminium conductors weigh but half as much as copper conductors of equal capacity.

Metallurgical Apparatus.—Among the products of the Patterson Foundry and Machine Company, of East Liverpool, Ohio, of interest to metallurgists and chemists are grinders and pulverizers, filter presses, engines and pumps, and elevating and conveying machinery. A small size filter press built along the lines of the standard "Patterson Round Rail" press and a line of small grinding cylinders are made specially for laboratory use.

Gasoline and Distillate Hoist.—The R. Kelly Machinery Company, of Los Angeles, Cal., recently placed a new gasoline and distillate hoist on the market. The engine is of the marine type and is built in units of 10-hp each. If additional power is required it can be obtained by adding extra cylinders. The hoist can readily be taken apart for the purpose of transportation, and where desired the base and sides are made of one solid casting, insuring the greatest possible strength.

Hopkins Fumeless Zinc Process.—A company has incorporated in Great Britain with a capitalization of $45,000 under the name of the Hopkins Fumeless Zinc Process Company. The purpose of the concern is to acquire and turn to account any improved processes for smelting zinc, especially that process covered by the patents of Reverend E. H. Hopkins. In this issue is an article fully describing the process.

Crucible Firm Organized.—The North British Crucible Company, Limited, has been incorporated in England to manufacture crucibles and like products. The capitalization is fixed at $25,000 and the address registered is 24 Blythswood Square, Glasgow.

Rustless Metal Organization.—The Rustless Metal Company, Limited, has been incorporated in England with a capital of $10,000. Of this $7500 is issued as common and $2500 as preferred stock.

Purifying Water with Ozone.—The United Water improvement Company, of Philadelphia, issues a pamphlet arranged in rather popular form describing their process for the purification of water by ozone. The ozone, electrically produced, is brought into close contact with, and partly dissolved in, water divided into a foamy consistency in the pipes arranged for the purpose. By this means it is said that the ozone combines with the carbon constituents in the pathogenic organisms, thus destroying them. The company lists apparatus in all sizes, from the small installations for domestic use up to municipal plants.

Oxy-Acetylene Welding and Cutting.—The great convenience of the oxy-acetylene process of welding iron, steel and other metals, even aluminium, is now so well recognized that it is being introduced into many factories and repair shops. It is rapidly replacing riveting in sheets up to ½ in. thickness, since it is less expensive, more efficient, and gives neater results. For cutting iron or steel plates the oxy-acetylene burner is much more rapid than pneumatic tools, punches or shears. It is, therefore, not surprising that there are now quite a number of concerns in this country furnishing oxy-acetylene apparatus. We have just received the catalog of the American Oxygen Company, 430 Perry Building, Philadelphia, Pa. It illustrates their torch, special features of which are said to be the method of mixing the gases, the regulation of the oxygen gas by a shut-off cock in case of flash-outs. Their acetylene pressure generator withstands a pressure of 50 lb. But the working pressure is given as 12 lb. The company has an oxygen plant in Camden, N. J., for the production of 10,000 cu. ft. of oxygen daily. While they furnish oxygen gas in high or low-pressure tanks, they are also developing a small portable oxygen generator for use at such places which are too far away from their oxygen-supply station.

Additional Power Installation.—On January 1, the Virginia (Minn.) Electric Power & Water Company began the operation of the additional power apparatus, which has just been installed by the Allis-Chalmers Company. The new apparatus consists of a 37-kw, low-pressure turbine direct-connected to a 2300-volt, 60-cycle, three-phase alternator. The turbine receives steam at a pressure of 16½ lb. absolute and a 28-in. vacuum is maintained by a Tomlinson type "C" condenser. Provision is made for supplying the steam ordinarily from the exhaust of a reciprocating engine, but in case of necessity high-pressure steam can be supplied direct from the boilers through a reducing valve.

Reconstruction of Works.—The American Platinum Works, of 251-255 New Jersey Railroad Avenue, Newark, N. J., have acquired by purchase the real estate and building formerly owned and occupied by the Caffrey Leather Company and J. Liebstein & Sons, located at 225, 227, 229 and 231 New Jersey Railroad Avenue, Newark, covering half a block on that avenue (110 ft.) and having a frontage of 250 ft. on Oliver Street and 30 ft. on Chestnut Street. The present buildings will be reconstructed and modernized and additional structures will be erected, which, when finished, will give this company one of the most complete plants in the world for the refining of platinum, gold and silver.

Addition to Plant.—The Northern Engineering Works, builders of "Northern cranes," Detroit, Mich., have purchased additional land adjoining their plant on which they are preparing to make extensions of their crane plant.

Power from Exhaust Steam.—The fact that only a small portion of the available energy in steam is turned into work by engines when exhausting to atmosphere, and that reciprocating engines are not adapted to operate with high vacuums has caused considerable investigation lately as to the best methods

of getting more work out of the steam. . The method of using a low-pressure turbine working on the exhaust of a high-pressure reciprocating engine has lately come into use. However, in the majority of cases, the amount of steam exhausted by the engine is not proportional to the amount of steam needed by the turbine. This is especially true in the case of rolling-mill engines, hoisting-mill engines, etc., where the exhaust is intermittent. A new apparatus, known as a regenerator, has recently been put on the market for absorbing any surplus steam and storing it up to use in the turbine when the exhaust supply ceases. A booklet entitled "Power from Exhaust Steam," published by the American Regenerator Company, Monadnock Block, Chicago, Ill., goes into this subject quite fully and shows by calculations how the maximum amount of available energy in exhaust steam can be turned into useful work. There are also diagrams showing the comparison of efficiencies of various combinations of reciprocating engines and steam turbines.

Addition to Hydroelectric Plant.—The Portland (Ore.) Railway, Light & Power Company is again increasing the capacity of its hydroelectric plant. It has recently placed an order with the Allis-Chalmers Company for a 3750-kw waterwheel type, 11,000-volt, 60-cycle, three-phase, 360-r.p.m. alternator. This will be of the same general design as the two 2500-kw, 11,000-volt, 33-cycle alternators already supplied by the same company, and will be semi-enclosed. A 50-kw, 120-volt exciter will be direct-connected to an extension of the alternator shaft.

Gold in New York State.—Mr. John M. Clarke, New York State geologist, recently made a report to the Legislature dealing with the supposed gold sands of the Adirondacks, which have attracted so much attention from promoters and prospectors. He concludes that while they contain traces of the precious metal, they do not afford any basis for mining enterprises. "While deficient in the precious metals, the Adirondacks region possesses the elements of large mineral wealth. Its production of iron ores, talc, garnet, graphite, pyrite, and building and monumental stones of various character is a very important contribution to the mineral output of the country. There is abundant opportunity for future development of such resources, and it is in that direction rather than in the seeking of the precious metals that energy and capital can be best employed."

Combination of Firms.—The Trent Engineering Company, composed of the firms of L. C. Trent & Company, of Salt Lake, and the Trent Engineering Company, of Reno, Nev., having combined, have opened a branch office in Los Angeles, Cal., for the extension of its business and for the better convenience of its clients.

Foundry Supply.—Among the catalogs received at our new Pittsburgh office may be mentioned catalog No. 37 of the J. D. Smith Foundry Supply Company, of Cleveland, Ohio. The book is quite complete and covers foundry supplies of all kinds, facings and general equipment. Standard natural draft crucible ovens, core ovens and core-making machines are worthy of special mention.

Dependable Engineering Specialties is the title of the fully illustrated catalog No. 9 of the Wm. Powell Company, of Cincinnati, Ohio, which covers a great many types of valves, globe, gate, check, blow-off and throttle, as well as cocks, lubricators, injectors, whistles and other details. A number of tables of useful information are included. Metallurgists who have in operation steam or gas engines will find this catalog convenient.

Metallurgical Machinery.—Among the most complete sets of catalogs we have received is an assortment from the Wellman-Seaver-Morgan Company, of Cleveland, Ohio. Two general divisions are treated and are outlined in two little illustrated booklets: I. "What We Do in Iron and Steel Works Machinery, Etc." II. "What We Do in Mining and Power Machinery." Each field is covered by catalogs on various specialties, such as open-hearth and reheating furnaces, charging and manipulating apparatus, cranes, buckets, gas producers, reversing valves, hoisting engines and electric hoists, cages and ore cars, tube and ball mills, concentrators, etc. The publication on "Ore and Coal Handling Machinery" is worthy of special commendation.

Sherarduct.—A number of circulars from the National Metal Molding Company, of Pittsburgh, Pa., announce their product "Sherarduct," an iron pipe conduit rendered non-corrosive by sherardizing. This process of galvanizing has frequently been mentioned in these columns and, it will be recalled, consists of enclosing the cleaned metal, together with zinc and zinc oxide dust, in a chamber which is then heated to about 600° Fahr. The zinc alloys, with the iron and a coating of pure zinc, remains on the surface. The United States Sherardizing Company, of New Castle, Pa., owns the American patents and has given licenses to several companies which are now "dry-galvanizing" a variety of articles.

Gas Producers and Valves.—A couple of artistic catalogs from the Forter-Miller Engineering Company, of Pittsburgh, Pa., describe their specialties, water-seal gas producers and water-seal reversing valves, together with open hearth, crucible, reheating and annealing furnaces built by this firm.

The Buckeye Engine Company of Salem, Ohio, has issued a trio of publications. The first deals with steam engines in different forms in sizes up to 8000 hp, while the second treats of four-cycle gas engines from the small sizes to the heavy twin double-acting tandem engines of 6000-hp capacity. The comparisons between thermal efficiencies of steam and gas engines and the typical analyses of various power gases are instructive. "The Sun That Never Sets" is a neat booklet on the Buckeye blue printing machine.

Small Gas Engines.—In the gas-engine field, a field of constantly growing importance in the iron and steel and general metallurgical industries since the more universal introduction of the gas producer, might be mentioned publications of the Foos Gas Engine Company, of Springfield, Ohio. This concern appears to specialize in engines of small and moderate size, say up to 150 hp. The machines are four-cycle, single-acting; the horizontal type has one, and the vertical two, three, or four cylinders. "Foos Junior" equipments are made in from 2-hp to 8-hp units.

Electric Control Apparatus.—From the Pittsburg office of The Electric Controller and Manufacturing Company comes a set of folders illustrating their line of magnetic brakes, motor starters, controllers, magnetic switches and solenoids, electric fault finder, and the well-known lifting magnets. This company has adapted its products particularly for the iron and steel industry, and has now a great many successful installations to its credit.

Laboratory Materials.—A valuable reference book for purchasing agents, chief chemists, and college professors is the catalog of the Scientific Materials Company, of Pittsburgh. The list is remarkably complete and includes some 3000 different forms of apparatus used in chemical laboratory work, each one of which is listed in all the sizes ordinarily used. With the alphabetical classification and the 2000 illustrations accompanying the descriptions, no difficulty is experienced in rapidly locating anything desired.

Additional Catalogs Received.—Among the publications received at our Pittsburgh office which it is not possible to review this month are bulletins from the Lincoln Electric Company and the Triumph Electric Company on small motors and generators; the Bruce-Macbeth Engine Company and the Miller Improved Gas Engine Company, on gas engines; William B. Scaife & Sons Company, on high-pressure tanks and water filters; the Bickford Firebrick Company, and the Grasselli Chemical Company.

Personal.

Mr. **John Fritz**, of Bethlehem, Pa., has been elected an honorary vice-president of the Iron and Steel Institute of Great Britain.

Mr. **Philip Argall** announces that in order to give prompt attention to his rapidly increasing business, he entered on Jan. 1 into partnership with Mr. Philip Henry Argall, late of the Selby Smelter, and Mr. George Oates Argall, general manager of the Iron Silver Mining Company, of Leadville, Col., with the purpose of conducting a general business as consulting, mining and metallurgical engineers, under the name of Philip Argall & Sons. The offices of the firm are in the Majestic Building, Denver, Col.

Dr. **Ernst J. Lederle,** consulting sanitary engineer for the New York City Board of Water Supply and a member of the New York State Water Supply Commission, has been appointed commissioner of the New York City Health Department. Dr. Lederle occupied the position before, during the Seth Low administration, beginning in 1902.

Mr. **G. H. Dowell,** who for a number of years has been employed by the Phelps-Dodge interests at the Douglas, Ariz., smelter, has been appointed general manager of the Old Dominion. Mr. George Kingdon, who has been acting superintendent since the resignation of Mr. R. B. Hegardt some time ago, will henceforth be superintendent of mines, and also general superintendent of the United Globe property controlled by the Old Dominion Copper Mining and Smelting Company.

Mr. **E. B. Raymond,** who has been General Superintendent of the Schenectady works of the General Electric Company, is leaving that concern to enter the employ of the Pittsburgh Plate Glass Company in the position of second vice-president. Mr. Raymond is a graduate of the Massachusetts Institute of Technology, class of 1890.

Mr. **Donald G. Miller** is doing engineering work at Pilares de Nacogori, Sonora, Mexico, for the Montezuma Copper Company.

Mr. **Fred B. Crosby** has left the power and mining department of the General Electric Company to take up a position as technical writer with the publication department of the Westinghouse Electric & Manufacturing Company.

Mr. **Frederick H. Keyes,** formerly general manager of the Robb-Mumford Boiler Company, on Jan. 1 associated with Messrs. T. W. Sprague, H. D. Jackson and others to carry on a general consulting engineering business. The offices of the firm will be at 88 Broad Street, Boston.

Mr. **Arthur A. Brown,** formerly manager of the Pittsburgh office of the Westinghouse, Church, Kerr Company, recently accepted a position in the sales department of the Westinghouse Electric & Manufacturing Company. Mr. Brown's headquarters will be in New York City.

Mr. **George C. Vivian** has severed his Utah mining connections, and has returned to Colorado, where on Jan. 1 he took charge as manager of the Golden smelter of the North American Smelter & Mines Company.

Mr. **W. D. Healy,** formerly of Detroit, Mich., has entered the employ of the Union Pacific Cobalt Company as manager.

Mr. **A. B. Emery** has been appointed assistant general manager of the Southern Division of Mexico Mines of the American Smelters Securities Company. Mr. R. E. Adams succeeds Mr. Emery as superintendent of the Velardeña district. Mr. W. M. Drury has been appointed assistant general manager of the Northern Division of Mexico mines of the company.

Mr. **Andrew McFarland,** of Colorado, has taken charge as general superintendent of the Lucia Mining Company, Gabrial, Durango, Mexico.

Mr. **C. M. Eye** has resigned as manager of the Benguet Consolidated Mining Company, at Bagulo, Philippine Islands, to take charge of the Colorado Mining Company at Aroroy, in the Island of Masbate. His successor with the Benguet company is Mr. Amos W. Cole, recently with the Oriental Mining Company, in Korea.

Mr. **Kamajiro Kajiura,** engineer for the Besshi Copper Mines Company, at Nuhama, Iyo, Japan, has been in this country recently studying the smelter fume and smoke problem. His company is operating its smelter on an island 10 miles from the coast of Japan, but even at that distance is having trouble with the farmers on the mainland, who complain of the fumes as a nuisance.

Mr. **I. Wayne Von Leer,** of New York, has been appointed manager of the Arizona United Mining Company, at Johnson, Ariz.

Mr. **Frederick N. Pease,** Assistant Chemist of the Pennsylvania Railroad has been appointed chief chemist to succeed the late Dr. Charles B. Dudley.

Professor **Theodore W. Richards,** of Harvard University has been reappointed research associate of the Carnegie Institution. With the appointment he receives a new grant of $2,500 to enable the continuation of his researches regarding atomic weights and physico-chemical constants. At the last meeting of the Chemists' Club, of New York City, which was in the form of a Harvard night, Professor Richards was made an honorary member of the club.

Dr. **Rudolph Messel** has been appointed Honorary Foreign Secretary of the Society of Chemical Industry to take the place of the late Dr. Ludwig Mond. Professor A. Liversidge, F.R.S., has been appointed a vice-president of the society, succeeding Dr. Mond.

Dr. **L. F. Guttman,** formerly of the chemical department of the College of the City of New York, has been called as assistant professor of chemistry to Queen's College, Kingston, Ontario, Canada.

Mr. **W. M. Tattersall** has been appointed keeper of the Manchester (England) Museum, to succeed Dr. W. E. Hoyle.

Professor **J. Culver Hartzell** has resigned as head of the department of geology and chemistry at the University of the Pacific. The resignation is to take effect at the close of the present academic year.

Dr. **Albert P. Sy** has become director of the chemical laboratories and professor of chemistry at the University of Buffalo, succeeding Dr. H. N. Hill, resigned.

Dr. **Austin M. Patterson** has been elected Editor of *Chemical Abstracts,* to succeed Dr. W. A. Noyes. Mr. John M. Miller becomes associate editor.

Dr. **Henry M. Payne,** who recently resigned his position as professor of mining engineering at the University of West Virginia, has been appointed field manager of the Hydraulic Mining Cartridge Company, of 42 Broadway, New York City.

Dr. **Benzo Katsura,** Professor of Metallurgy in the Imperial Tokio (Japan) University, was a recent visitor to the United States and made a tour of the metallurgical plants of the country. He secured many publications for the University library.

Dr. **J. L. Simonsen,** assistant lecturer and demonstrator in the chemical department of the University of Manchester (England), has been called to the chair of professor of chemistry at the University of Madras (India). Dr. A. Holt takes the place left vacant by Dr. Simonsen at Manchester.

Dr. **G. Gürich,** docent in the department of geology at Breslau, has been appointed director of the Geological Institute at Hamburg, to succeed the late Professor Gottsche.

M. **Emile Picard** has been chosen president of the Paris Academy of Sciences for 1910. The place he formerly held as vice-president will be filled by M. Armand Gautier.

Dr. **Charles Graham,** formerly professor of chemical technology at the University College, London, has bequeathed his residual estate, which is estimated to amount to $175,000, to the college for research in the School of Advanced Medical Studies at the University of London.

Dr. **Ernst J. Berg** is now head of the electrical engineering department at the University of Illinois, having left the General Electric Company to take up this new position. He is a native of Sweden, receiving his education at the Royal Institute of Technology, Stockholm, graduating in 1892, and coming at once to America. While with the General Electric Company

he became chief assistant to Dr. Steinmetz. For the past two years he was Consulting Professor of Electrical Engineering at Union University. Recently he received the degree of Sc.D. from that institutior

Tau Beta Pi.—The twenty-third chapter of Tau Beta Pi, the honorary engineering fraternity, was installed at Cornell University on Jan. 17, by Professor L. E. Moore, assistant professor of civil engineering at the Massachusetts Institute of Technology, and president of the fraternity.

The **Society of Sigma Xi** held a business meeting and banquet in Boston on the afternoon and evening of December 29, on the occasion of the meeting of the American Association for the Advancement of Science.

Phi Lambda Upsilon.—There is now at Columbia University a chapter of the honorary chemical fraternity, Phi Lambda Upsilon. Its faculty members are Profs. C. F. Chandler, M. T. Bogert, J. L. R. Morgan and H. C. Sherman. Mr. J. B. Barnitt is president of the chapter, Mr. Charles Crew is vice-president, and Mr. Robert Schwarz secretary-treasurer.

American Electrochemical Society

Seventeen applicants were elected to membership in the American Electrochemical Society at the meeting of the board of directors of that organization held in Philadelphia on Friday, Dec. 31, 1909. Announcement is made that the next meeting of the society will be held in Pittsburgh the latter part of April.

The list of new members elected follows:

Messrs. Augustus H. Eustis, Mining Engineer, Boston, Mass.; Walter L. Badger, Chemist, Great Western Sugar Company, Brush, Col.; William S. Barwick, Chemist and Metallurgist, The Vancouver Engineering Works, Vancouver, B. C.; Charles E. Skinner, Engineer, Research Division, Westinghouse Electric Manufacturing Company, Wilkinsburg, Pa.; George M. Colvocoresses, Superintendent, Millerett Silver Mining Company, Gowganda, Ontario; Lorain E. Imlay, Superintendent, The Niagara Falls Power Company, Niagara Falls, N. Y.; Harold Binney, of Binney, Mastick and Ogden, New York City; James D. Pickard, Mechanical Engineer, The Colorado Vanadium Company, Boulder, Col.; Edgard de Souza, Chief Electrical Engineer, The S. Paulo Tramway Light and Power Company, Ltd., S. Paulo, Brazil; C. H. Bowman, President, Montana State School of Mines, Butte, Montana; Jorge Newbery, City Electrical Engineer, Buenos Ayres, Argentine Republic, S. A.; Frederick H. Loveridge, Electrical Engineer, Western Electric Company, Chicago, Ill.; T. K. Armachela, Assistant Engineer, Public Works Department, Mysore Government, Bangalore, S. India; Floyd D. Taylor, Student of Electrochemical Engineering, The Pennsylvania State College, State College, Pa.; Herbery F. Sill, Assistant Professor of Chemistry, Carnegie Technical Schools, Chemical Dept., Pittsburgh, Pa.; Bradley Stoughton, Consulting Electric Furnace Engineer, New York City; William J. Cummings, C. E., Chief Engineer, E. I. DuPont Powder Company, Haskell, N. J.

American Chemical Society

The following have been elected to membership in the American Chemical Society.

Clive M. Alexander, Iowa City, Ia.; Edward X. Anderson, Iowa City, Ia.; Joseph C. Andrews, Ithaca, N. Y.; Olney P. Anthony, Norwood, Mass.; Eli H. Armstrong, East Point, Ga.; Philip S. Beebe, Columbus, Ohio; O. W. Boies, Ithaca, N. Y.; Thomas Roland Briggs, Ithaca, N. Y.; James Brown, Aledo, Ill.; Guiseppe Bruni, University of Padua, Padua, Italy; J. R. Bryce, Ithaca, N. Y.; William McG. Burns, Boston, Mass.; Howard N. Calderwood, Jr., Lawrence, Kan.; R. S. Callaway, Minneapolis, Minn.; Horace H. Clark, Chicago, Ill.; Albert D. Conley, Orono, Maine; L. S. Cozzens, Freeport, N. Y.; L. J. Cross, Ithaca, N. Y.; H. A. Crown, Ithaca, N. Y.; Raphael Dennery, New Orleans, La.; Miss Mary V. Dover, Mount Holyoke College, South Hadley, Mass.; Carl Englund, Vermillion, S. D.; J. Clifford Evans, Millville, N. J.; Edgar M. Flint, New York City; William R. Flint, New Haven, Conn.; H. J. Glück, Ithaca, N. Y.; Benjamin H. Harrison, Champaign, Ill.; Ellwood Hendrick, New York City; J. J. Hinman, Jr., Indianapolis, Ind.; August Holmes, Reno, Nev.; Arthur E. Houlehan, Ithaca, N. Y.; I. W. Humphrey, Lawrence, Kan.; Vasco Hunez, Ithaca, N. Y.; W. Lawton Iveson, Toronto, Canada; José Jauer, New York City; R. L. Jones, Nashville, Tenn.; Forrest W. Kehoe, Great Barrington, Mass.; Theodore B. Kelly, Berkeley, Cal.; William J. Kelly, Leipzig, Germany; James Kewley, Balik Papan, East Borneo; W. A. Koenig, Philadelphia, Pa.; Herbert G. Kribs, Philadelphia, Pa.; David Mauson, New York City; A. O. Mason, Ithaca, N. Y.; W. H. Maynard, Knoxville, Tenn.; H. G. McCoy, Ithaca, N. Y.; Cyrus L. Merriam, Santa Lucrecia, V. C., Mexico; James Hill Miller, Dublin, Ireland; Harry W. Morse, Cambridge, Mass.; J. E. Myers, Albany, N. Y.; James H. Pettit, Urbana, Ill.; W. L. Ray, Madison, Wis.; Burleigh B. Reed, Iowa City, Ia.; Harold E. Riegger, Ithaca, N. Y.; Joseph Rosin, Philadelphia, Pa.; Miss Jennie L. Rowell, Burlington, Vt.; Harvey Schackelford, Columbia, Mo.; C. Silver, Ithaca, N. Y.; Arthur Smith, Toronto, Canada; Erwin Sohn, Cleveland, Ohio; Walter A. Sperry, Columbus, Ohio; Fred C. Stewart, Portland, Maine; Harry M. St. John, Ithaca, N. Y.; F. W. Stockton, Lawrence, Kan.; S. Sutker, Gadsden, Ala.; Edward Tapp, Chicago, Ill.; Claude S. Tingley, DeLand, Fla.; W. F. Walker, Mulberry, Fla.; Harry V. Welch, Berkeley, Cal.; LeRoy F. Whipple, Kingston, R. I.; R. A. Winser, Aurora, Ill.; Malcolm G. Wyer, Iowa City, Ia. The Procter & Gamble Company, of Cincinnati, Ohio, and the George A. Schmidt Company, of Chicago, Ill., were admitted to corporation membership.

NEW BOOKS.

MORGAN, J. LIVINGSTON RUTGERS. Physical Chemistry for Electrical Engineers. Second edition, revised. 259 pages, illustrated. Price, $1.50. New York: John Wiley & Sons.

NAGEL, OSKAR. The Transportation of Gases, Liquids and Solids by Means of Steam, Compressed Air and Pressure Water. A complete description of the theory, construction, operation and application of jet machines, montejus, spray nozzles, etc., for chemical, metallurgical, mining, mechanical and civil engineers, with 193 illustrations. 212 pages. Price, $2.00 net. New York: Oskar Nagel (P. O. Box 385).

THORPE, Sir E. History of Chemistry. In two volumes. Vol. 1. From the earliest times to the middle of the nineteenth century. 217 pages. Price, 75 cents net. New York: Putnam.

ALLEN, ALFRED H., M. D. Commercial Organic Analysis. Fourth edition. Vol. 1, introduction. Alcohols, yeast, malt liquors and malt, wines and spirits, neutral alcoholic derivatives, sugars, starch and its isomerides, paper and paper-making materials, vegetable acids. Edited by Henry Leffman and W. A. Davis. 586 pages. Price, $5.00 net. Philadelphia: P. Blakiston's Son & Company.

LEACH, ALBERT ERNEST. Food Inspection and Analysis. For the use of public analysis, health officers, sanitary chemists and food economists. Second edition, revised and enlarged. 972 pages, illustrated. Price, $7.50. New York: John Wiley & Sons.

WATERBURY, LESLIE ABRAM. A Vest Pocket Handbook of Mathematics for Engineers. 197 pages, cloth. Price, $1.50. New York: John Wiley & Sons.

MACLAURIN, RICHARD COCKBURN. Light. Cloth, 257 pages. Price, $1.50. New York: The Macmillan Company.

NAGEL, OSKAR. Producer Gas Fired Furnaces. Cloth, 187 pages. Price, $2.00 net. New York, the author, P. O. Box 385.

BOOK REVIEWS.

The Mechanical World Pocket Diary and Year Book for 1910. 300 pages, price 6d. (Retail price in New York, 25 cents.) Manchester, England: Emmott & Company, Ltd.

This handy little reference book has undergone a number of improvements this year. First of all, it has been reduced in bulk by the use of thinner paper, although considerable new matter has been added.

The gas engine section has been thoroughly revised and a new section on oil engines added. A section on ball bearings and some things on centrifugal pump design have also been added. There are numerous other additions, most of which relate to the construction and design of machine details, such as gears, bearings, etc.

The 300 pages of text are well filled with data condensed in a most concise form. The collection of tables is exceptionally well chosen and will be found most useful to those who have to do with the installation and operation of prime movers.

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The Mechanical World Electrical Pocketbook for 1910 175 pages, price 6d. (Retail price in New York, 25 cents.) Manchester, England: Emmott & Company, Ltd.

This is a companion to the Mechanical World Year Book, and is evidently intended for mechanics and electricians rather than engineers. It contains very short descriptions of various apparatus and gives directions for wiring and installation of apparatus, testing of circuits and making simple measurements. The wiring practice is, of course, that laid down by the British code, and does not apply in this country. There is practically no data in tabular form that is not to be found in all handbooks; that is, tables of squares and cubes, areas and circumferences, logarithms, etc. This book is far behind its companion, the Year Book, as a reference book of useful data.

Les Découvertes modernes en Physique. By **O. Manville.** Second edition. 8vo, 462 pages. Price, 8 francs. (Retail price in New York, $2.10.) Paris: A. Hermann et Fils.

The work consists of two parts: the first deals with the relation of electricity and matter; the second with the rôle of ions and electrons in physical phenomena. The first part has chapters on the electric conductivity of liquids, of gases, the ionization of gases, and the electronic theory of matter. The second deals with electrolysis, electric discharge in gases, electric conductivity of metals. A supplementary chapter treats of the modern conceptions of the relations of matter and ether. Our general impression of the work is that it contains a great deal about interesting, modern developments, rather uncritically worked up. Twelve pages of notes and errata (mostly the latter), which the reader is asked to kindly insert at the proper pages (a labor of several hours), complete the volume.

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Analyse Thermique et Metallographie Microscopique. By **E. Rengade,** Docteur des Sciences, Chef de trauvaux, pratiques à la Faculté des Sciences. Cloth, 176 pages, 53 figures and 26 photographs. Price, $1.80. Paris: Librairie Hachette et Cie.

This book is intended for beginners. It has a preface by H. Le Chatelier which clearly sets forth the guiding ideas and topics the book treats of. Solutions, alloys, glasses, solders, rocks, etc., have until recently not been considered worthy of intimate study by chemists. By the newer methods these classes of natural objects have been made the subject of close scrutiny and the methods which this little work describes so tersely and clearly have been introduced into many laboratories. The first portion of the text deals with Gibbs' rule, which is made the starting point for the development of the succeeding chapters. Numerous illustrations add greatly to the elucidation of the topics discussed and at the end there is a chapter on the apparatus and the methods of thermic analysis. The use of the thermo-electric couple is given and apparatus whereby continuous records of the variations of the current can be secured. There is a special chapter on the iron-carbon system.

The second portion of the work is devoted to metallography. This part is illustrated by some excellent micro-photographs. The technical preparation of the metal is given and the simple character of the methods is in strong contrast with the great insight thus obtained into the structure of materials, particularly steels.

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Die Lack und Firnisfabrikation, by Professor **Max Bottler.** 130 pages, 29 illustrations. Price, 4.50 marks. (Retail price in New York, $1.50.) Halle, a. S.: Wilhelm Knapp.

This is No. 16 of a very interesting and valuable series of monographs on chemical, technical and manufacturing methods, edited by Mr. L. Max Wohlgemuth and issued by the publisher, Wilhelm Knapp.

In his preface the author says: "In the industries resting upon chemical bases, the manufacturer of lacquers and varnishes occupies a conspicuous position. In recent years this manufacturer has made important progress, partly in improvement of long known processes, but partly also in wholly new discoveries or processes. In the work before us will be found practical considerations of the newer inventions and technical advances. Special attention is given to the different methods of operation."

The author has well stated the plan and scope of the work. The nine chapters discuss the history of lacquers and varnishes, their classification, the raw materials of the industry, preparatory treatment and generalities, oil varnishes and fatty lacquers, oil of turpentine and benzine lacquers, alcoholic and other "volatile" and "non-volatile" lacquers, coloring, decolorizing and filtering lacquers and varnishes, preparation of printing and lithographing varnishes, soap lacquers, resinate lacquers, and casein lacquers.

Chemists seek in vain for good books in English on this subject, to serve as a guide for those directly or indirectly interested in the industry. For such as can read German this book will prove a boon, and all chemists, whether varnish makers or not, will find it a valuable addition to their working libraries.

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Cost of Mining. By **J. R. Finlay.** 415 pages. Price, $5 net. New York: McGraw-Hill Book Company.

It has ever been the aim of this journal to be broad, to look at the domain of chemical and metallurgical engineering from such a standpoint that things could be seen in their proper perspective, but at the same time to scrutinize the essential details necessary for practical success. In short, we have endeavored to be far-sighted in the right way and to be near-sighted in the right way without being piddlers. This being our aim in technical journalism, we are glad to call attention to Mr. Finlay's "Cost of Mining" because the author attains successfully in his book such a consummation.

Mr. Finlay has achieved success in various fields of human activity. At Harvard, he was noted as an athlete on the field and on the water. Later, after serving his engineering apprenticeship, he has managed successfully mining properties of the first and second magnitude in Cripple Creek, the Cœur d'Alenes, Lake Superior iron district, Joplin, the Flat River district and elsewhere. He has at different times acted as consulting engineer, lectured at Harvard University, and lately assumed charge as general manager of the Goldfield Consolidated Mines Company which is making the largest net profit of any gold property in the world.

Mr. Finlay is a master of lucid English and composition, and has contributed many good articles to the various mining journals. With such all-round ability in the author, little comment is needed on the book.

Mining and metallurgy are closely associated. The first finds the valuable ore and gets it out of the ground. The second takes the valuable ore and turns it into a product that can be sold at a profit. To make a rabbit stew, first catch and skin your rabbit; next be sure you have a fire and a stew-pan in which to prepare the rabbit for the table.

Looked at broadly, the question of cost of mining and treating of ores is of prime importance. For mining and reduction procedures are governed by the principles of economic science as well as by those of natural science and engineering science. Mr. Finlay, we are glad to note, always analyses the subject from the tests of cold-blooded business. This is perfectly proper in a book entitled "Cost of Mining." The evaluation of mining property is first taken up and incidentally a clear light is shed on the warped view that the public takes of mining investments. Next, the cost of development work or finding the ore, and stoping it, raising it, and reducing it is dealt with in a philosophic manner. Finally having laid down certain general principles, the author analyzes, from the viewpoint of these principles, the reports of representative coal, iron, lead, copper, silver, gold and zinc companies.

Many illuminating passages might be cited. On page 11 it is neatly shown how the efficiency of labor varies, being high in hard times and low in good times. The chapter on the U. S. Steel Corporation is especially good. On pages 371-3 a clear exposition is given of the dictum of the first Lord Brassey, a great English contractor, that the same work costs the same money all over the world regardless of the wages paid the unskilled laborer.

Everywhere in the book is seen due regard for the laws of economic science, which to our mind are as far reaching as the law of gravitation, though less immediate in their action.

This book is quite to our liking. It can be recommended alike to the student of finance, to the practical business man, to the mining engineer, to the chemical or metallurgical engineer, or in point of fact to anyone interested in the wresting of mineral wealth from Nature's bosom.